MACHINERY

DECEMBER 27, 1961 ONE SHILLING & THREEPENCE

HiFEED

serrated heavy duty milling cutters

Patent Application No. 8700/59

BRAYSHAW
TOOLS LIMITED
BELLE VUE WORKS,
MANCHESTER 12.
Phone: EASt 1046 (3 Lines)
Grams: Hardening M/C

HiFEED serrated heavy duty cutters are designed to provide a combination of high rate of stock removal and good surface finish.

Some of the advantages to be obtained are:—
SINGLE POINT CUTTING EFFICIENCY.
REDUCED LOAD AND VIBRATION on machine and work.
INCREASED PRODUCTION, particularly on work hardening and high tensile materials.
EFFICIENT HEAT DISSIPATION resulting from the break up of the cutting edges enables **HIGHER FEEDS AND SPEEDS** to be employed.

Primarily designed for heavy stock removal HiFEED cutters produce a surface finish acceptable for most applications. An alternative design, offering similar advantages plus superior surface finish when required, is also available.
HiFEED cutters INCREASE production REDUCE costs.
Send to-day for your copy of leaflet S.T.603.

H.A.P.'s

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BROACHING
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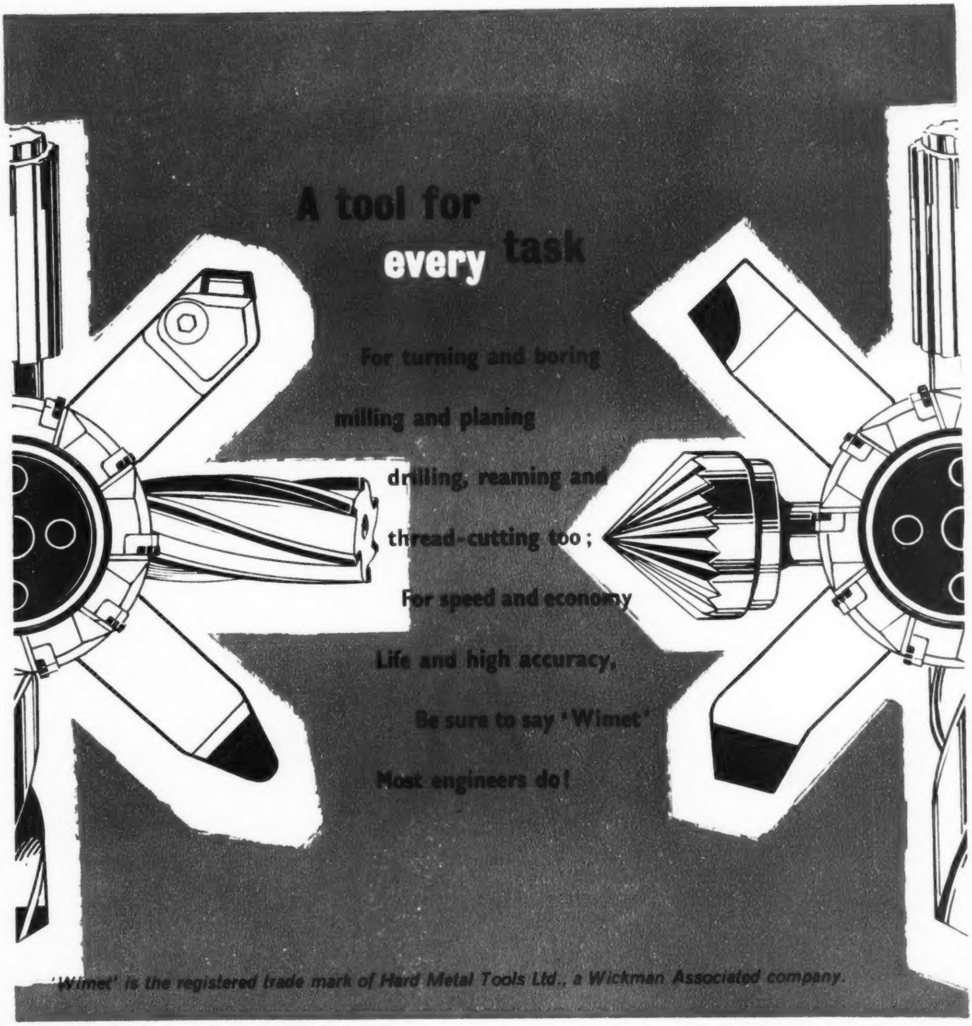

Wimet

CEMENTED CARBIDE CUTTING TOOLS

WICKMAN LIMITED

Wimet Division, Torrington Avenue, Coventry. Tel. Tile Hill 66621

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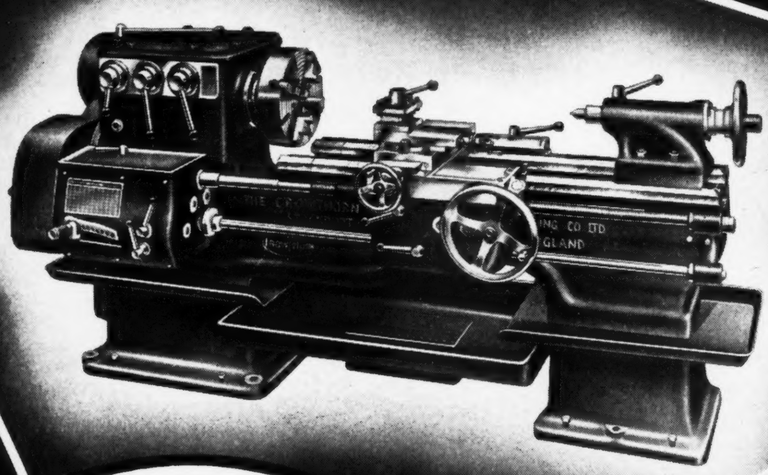
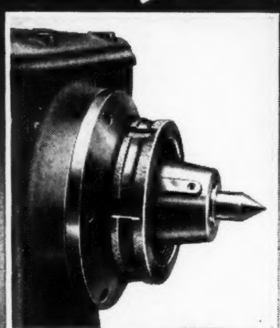


CROWTHORN

7½" & 8½" CENTRE LATHES

HIGH SPINDLE SPEEDS speeds of 1,000 r.p.m. and over can be provided when these lathes are fitted with profile ground gears and Gamet micron precision bearings in the headstock.

*



The detail photograph shows a close up of the L1 Long Taper Spindle Nose.

Other alternatives are screwed nose and A1 short taper nose

* *Ask for full details.*

CROWTHORN ENGINEERING COMPANY LIMITED

Makers of High Class Machine Tools for over half a century

REDDISH · STOCKPORT · ENGLAND

Phone: STOCKPORT 7271-2-3 *Grams: CROWTOOL, REDDISH*

CL.112

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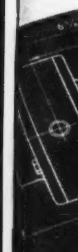

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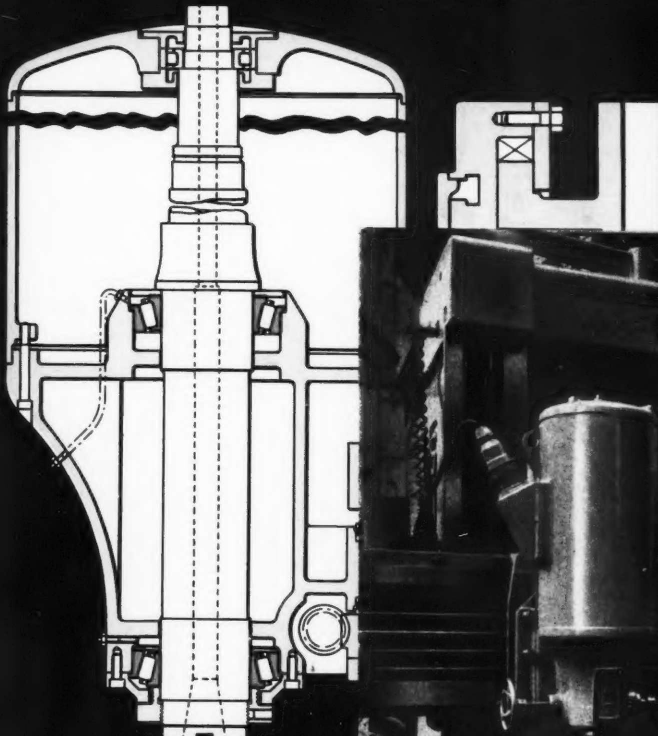

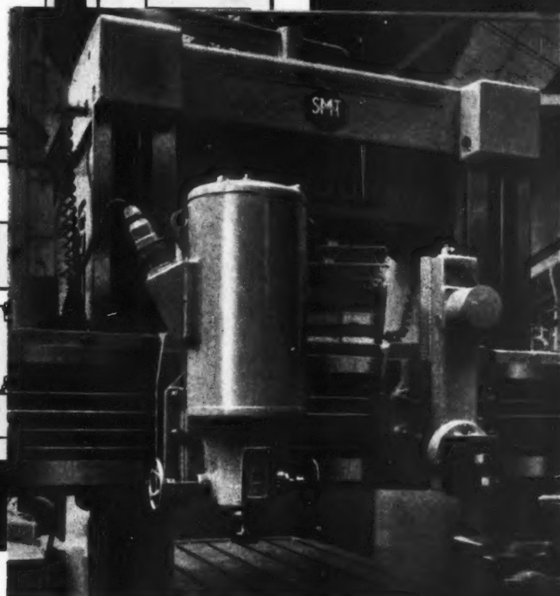
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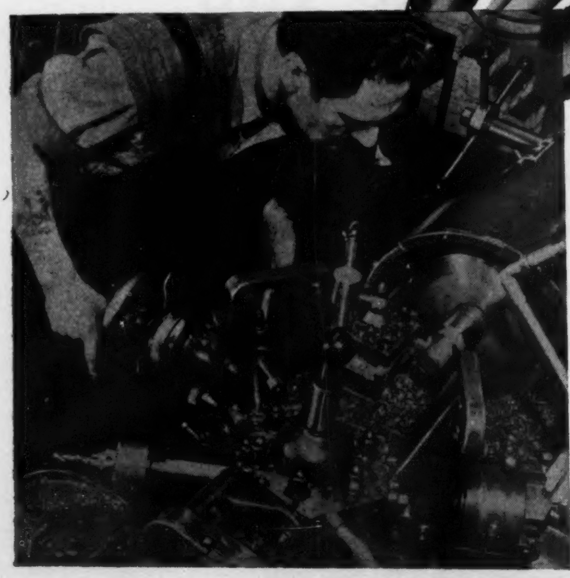
Super freecutting bright steel

Produced specifically for CAPSTANS and AUTOS

B.S. 970: 1955 EN 1A

The engineering trade has long recognised the superior quality of this freecutting steel, which has acquired a wide reputation for ease of machining, high cutting speeds, long tool life and the ability to produce components of excellent finish and accuracy. Usaspead super freecutting bright steel is closely controlled for chemical composition and mechanical properties, and responds readily to normal case hardening treatment.



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METAL COMPANY LIMITED

USASPEAD CORNER,
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Telex No. 22788

NEW MODEL "S" SUPER CHUCK

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FASTER
STRONGER
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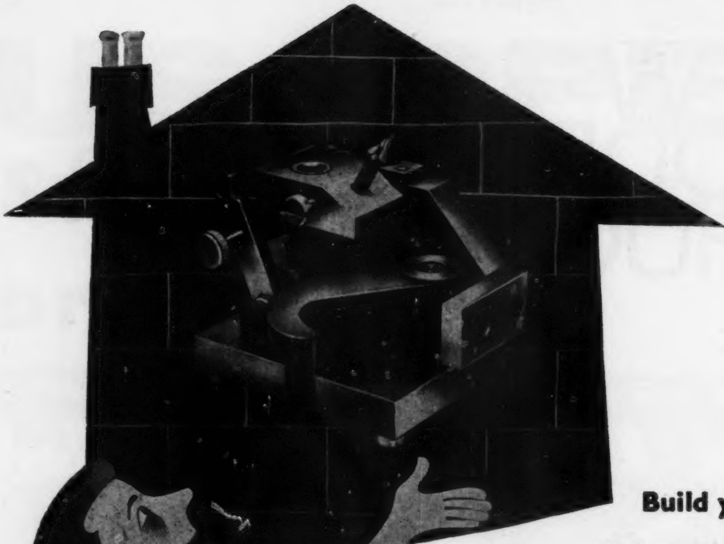

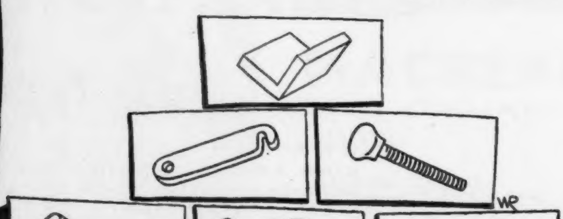
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Hayes
LEEDS

'DIEMASTER'

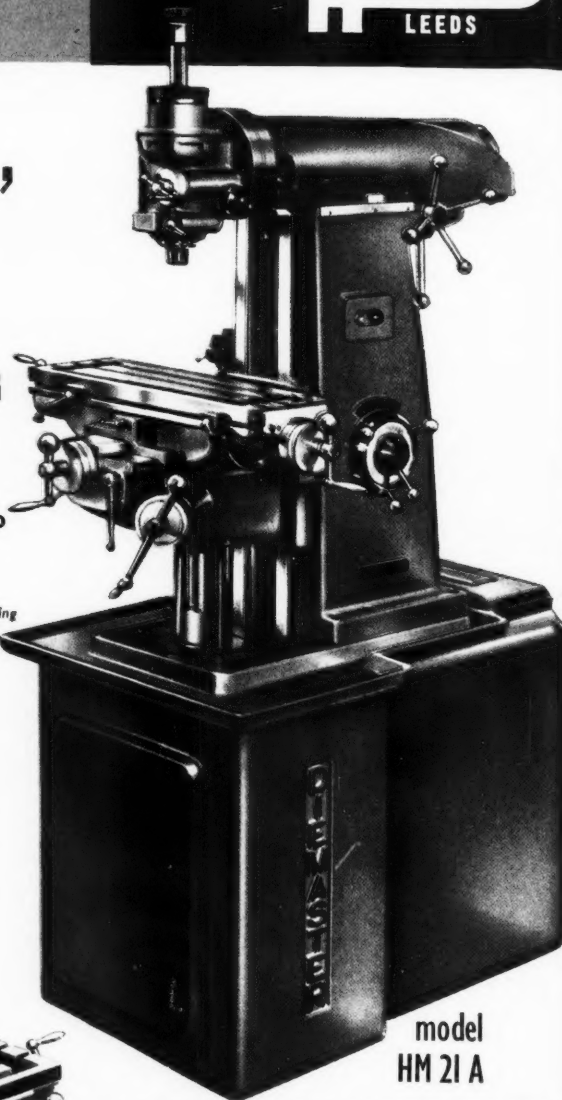
PRECISION VERTICAL MILLING MACHINE

WITH HARDENED & GROUND THREAD LEAD SCREWS

	HM 21 A	HMH 26 A with Hydraulic Copying
Table size	21" × 6¼"	26" × 8⅞"
TRAVERSE DIMENSIONS		
Table (Longitudinal) ...	12"	13"
Underslide (Lateral) ...	5"	5"
Knee (Vertical) with Vertical Milling Head ...	13¾"	13¾"
Knee (Vertical) with Horizontal Milling Head	16"	16"
Hydraulic Vertical Traverse	—	2½"
Maximum Height under Spindle Nose	13¾"	13¼"
Overarm Traverse ...	7¾"	7¾"
Working Area	12" × 12"	12" × 13"
9 Spindle Speeds	50–2,400 r.p.m.	50–2,400 r.p.m.

ADDITIONAL EQUIPMENT

High Speed Milling Head. 6 Spindle Speeds 1,000 to 6,000 r.p.m.
Horizontal Milling Heads. Jig Boring Equipment.
8" and 11" diameter Rotary Tables.



model
HM 21 A

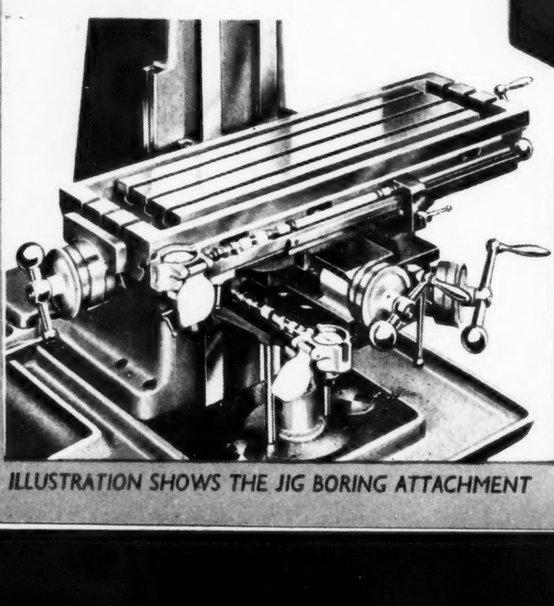


ILLUSTRATION SHOWS THE JIG BORING ATTACHMENT

HAYES ENGINEERS (LEEDS) LTD.

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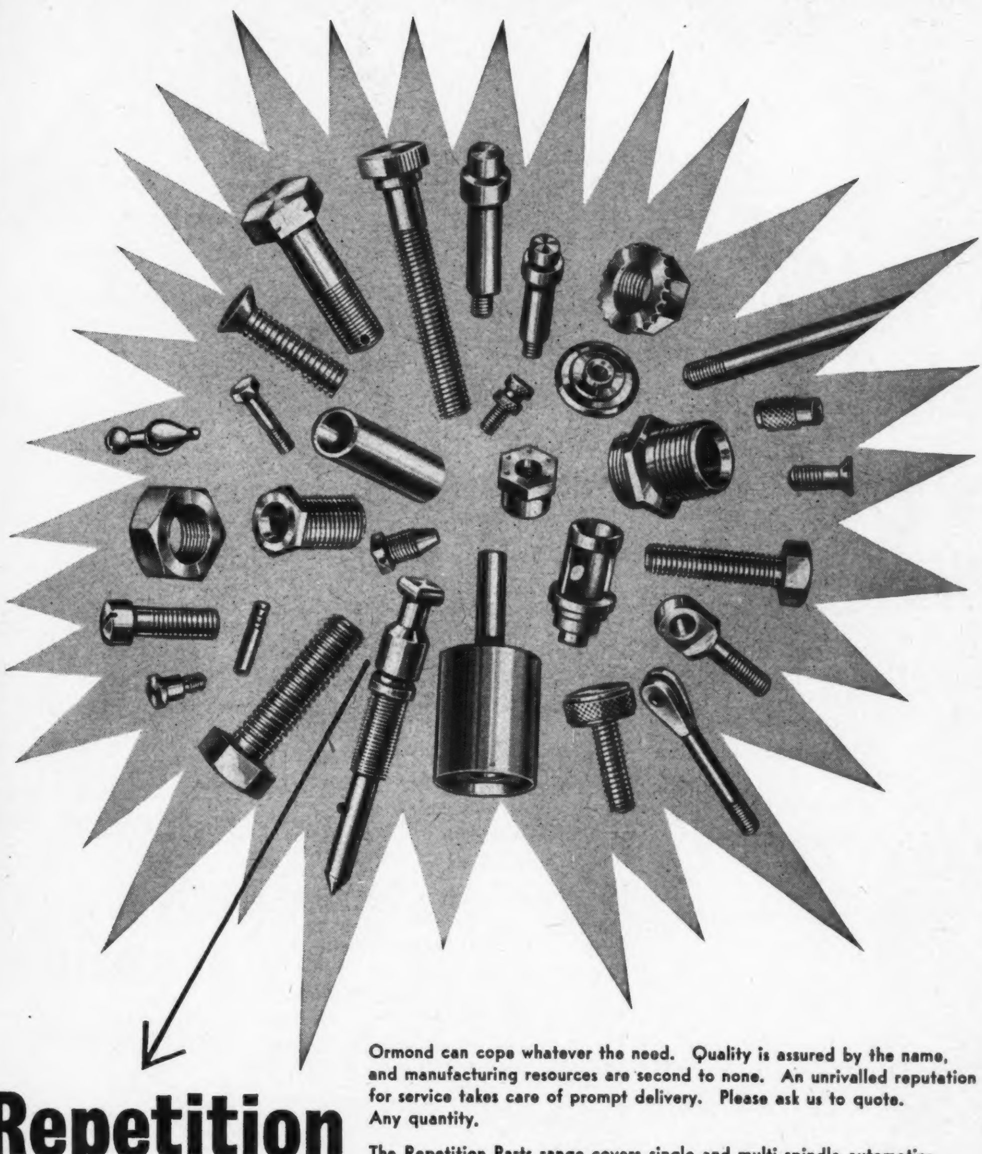

Repetition work

Ormond can cope whatever the need. Quality is assured by the name, and manufacturing resources are second to none. An unrivalled reputation for service takes care of prompt delivery. Please ask us to quote. Any quantity.

The Repetition Parts range covers single and multi spindle automatics up to $1\frac{1}{4}$" dia., Brass, Steel and Light Alloy Screws in Rolled and Cut Threads, Grubscrews, Nuts, Allthreads, Hexagon Bolts and Setscrews turned from bar and Cold Headed Grades "A", "B", and High Tensile.

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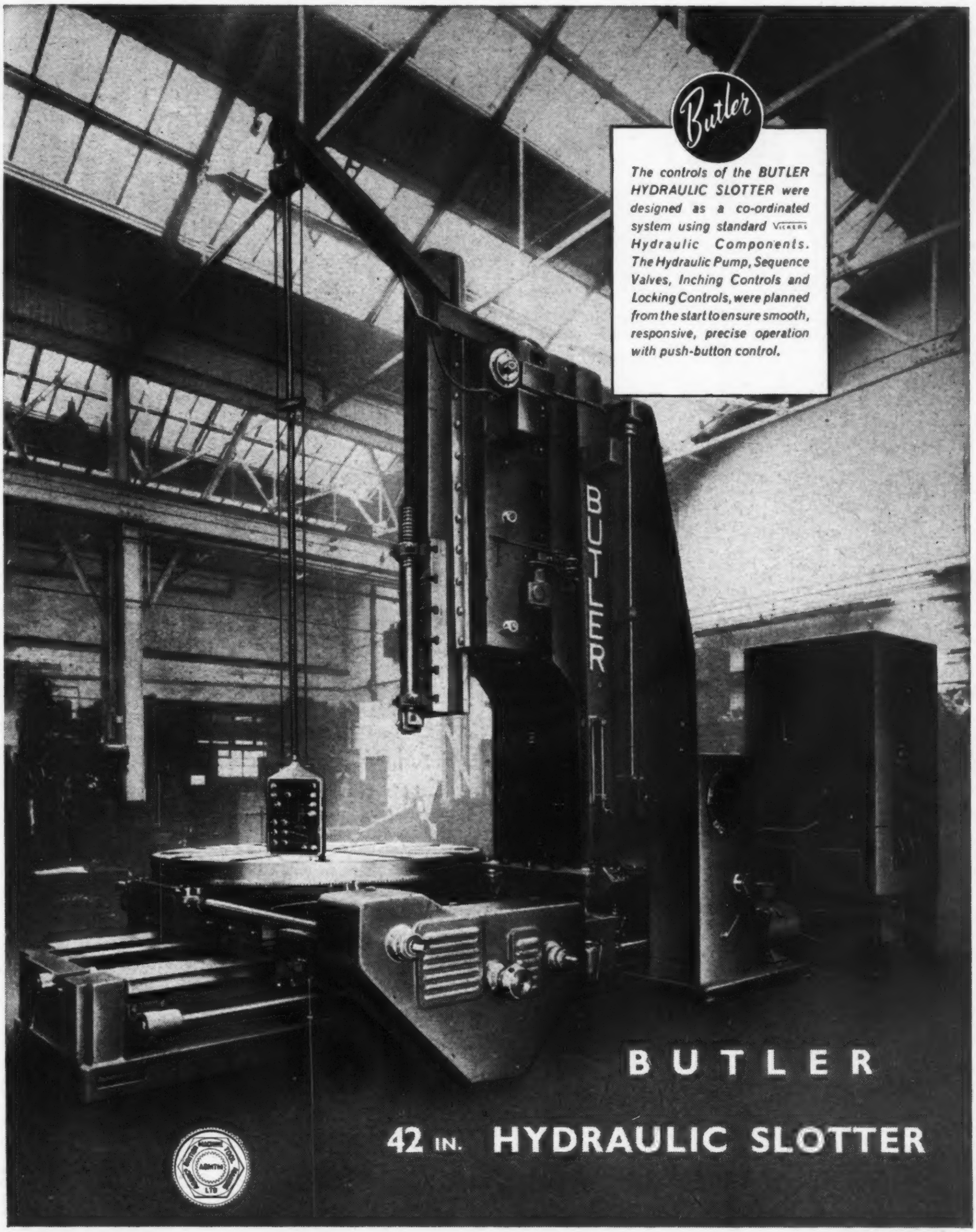
Butler
The controls of the BUTLER HYDRAULIC SLOTTER were designed as a co-ordinated system using standard VICKERS Hydraulic Components. The Hydraulic Pump, Sequence Valves, Inching Controls and Locking Controls, were planned from the start to ensure smooth, responsive, precise operation with push-button control.
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THOMPSON-DIATEST

High Precision

SMALL BORE

GAUGES

. . . . . a complete range of equipment to solve your checking problems

NO MORE TROUBLE GAUGING . . .
. . . blind bores, tapered bores, incomplete bores, barrel shaped bores, out-of round bores, where other bores interfere.

★ THOMPSON-DIATEST gauges can be operated by unskilled labour.

★ THOMPSON-DIATEST unit heads are hard chromium plated to withstand wear or can be supplied in tungsten carbide.

★ Simple adaptor converts the THOMPSON-DIATEST into an electronic bore comparator in conjunction with the MAGNA-GAGE or PARNUM.

★ Range 0.038" to 1.610" (1mm. - 40 mm.)

All Parts Interchangeable

185/187 HAMMERSMITH ROAD, LONDON, W.6.

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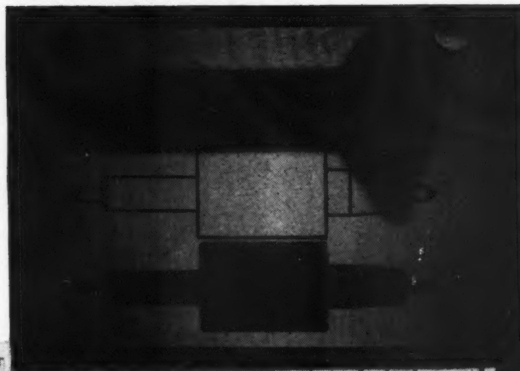
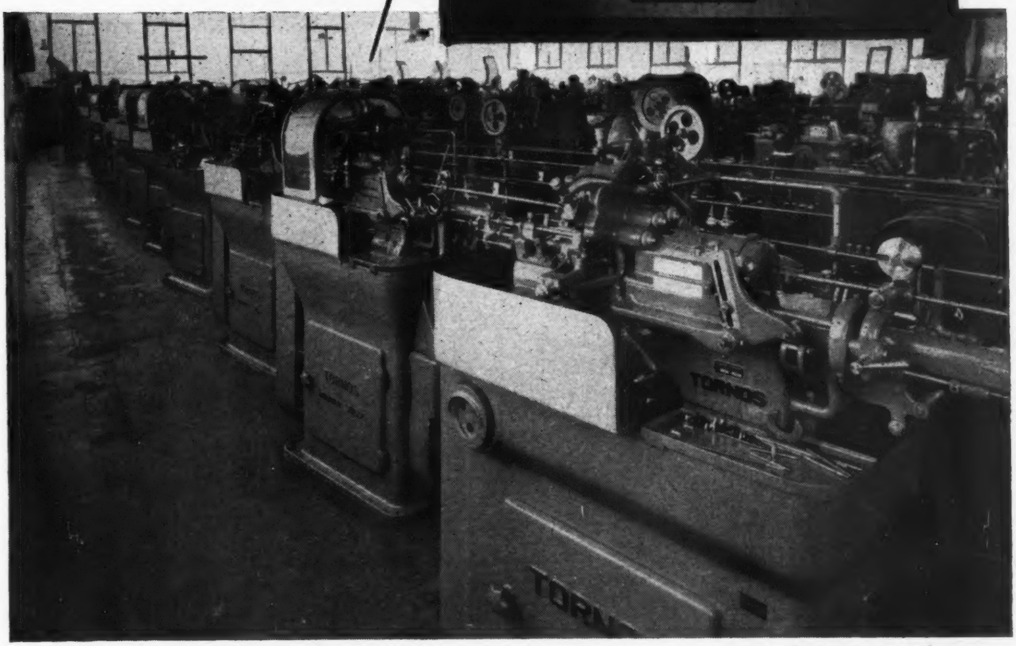
ultra precision and finish on parts SMALLER than a pin head





In the watch factory of S.SMITH & SONS (ENGLAND) LTD.

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sliding head Automatics

The TORNOS sliding head automatic with its unequalled performance, is ideally suited to the large scale production of both simple and intricate high precision parts. Eight models are available in the TORNOS range, with stock capacities from four to 32 mm. Write for full details.

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Spectra color

Engineers' layout fluid in transparent blue, now in handy aerosols

★ **Cannot spill or evaporate**
★ **Cuts out brushes and pots**
★ **Gives a thin, durable film of solid, even colour**
★ **Dries instantly—reduces waiting time**
★ **Cannot crack, peel, chip or flake**
★ **Resists petrol, water and most oils**
★ **Easily removed with Spectra Remover**

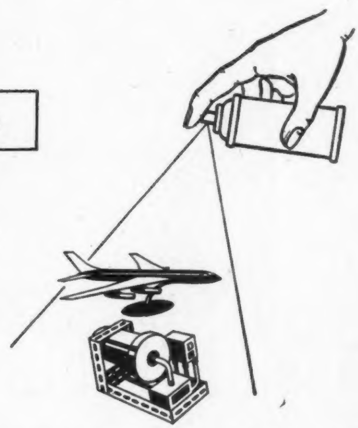
Now in handy aerosol form and even easier to use, Spectra Spray leaves a blue film which speeds marking off to very fine limits—gives greater accuracy in machining with less eye strain and lower incidence of scrap.
Each operator needing Spectra Color can now be supplied with an individual can, avoiding time loss in collecting and returning to stores.

In Transparent Blue only (6 fl. ozs.) Part No. SS1, 7/6 each. Carton lots of 12, 7/- each. 36 and above—carriage free.

Also available in other sizes and colours for brush application—write for details.

MAKE A BLUE-PRINT ON METAL FROM A BLUE-PRINT

Spectra *Cellulose* Spray Paints



For the small spray job on prototypes, models, machinery, mock-ups, "one-offs" etc.

★ **Available for instant use**
★ **Saves maintenance of spray guns for small jobs**
★ **Dries rapidly and evenly without brush marks**
★ **Fine mist delivery reaches inaccessible parts**
★ **Special non-clogging spray head—avoids tearing**
★ **Available in 14 colours and primer**

These handy spray cans are so easy to use—each coat is dry in a few minutes—reducing waiting time for additional coats.

APPLICATIONS For spray painting of jigs, models prototypes, radiators, small repair jobs, stencilling crates, part numbers—rapid colour coding—finishing display work, etc.

COLOURS AND PART NOS.

Red	PR	Dark Green	PT
Yellow	PY	Light Blue	PK
Fawn	PF	Dark Blue	PL
Brown	PB	Gold	PG
Light Grey	PD	Silver	PS
Dark Grey	PE	White	PW
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in 6 fl. oz. aerosols at 9/6 each. Cartons of six (colours to choice), 9/- each.

SPECTRA CHEMICALS LIMITED,
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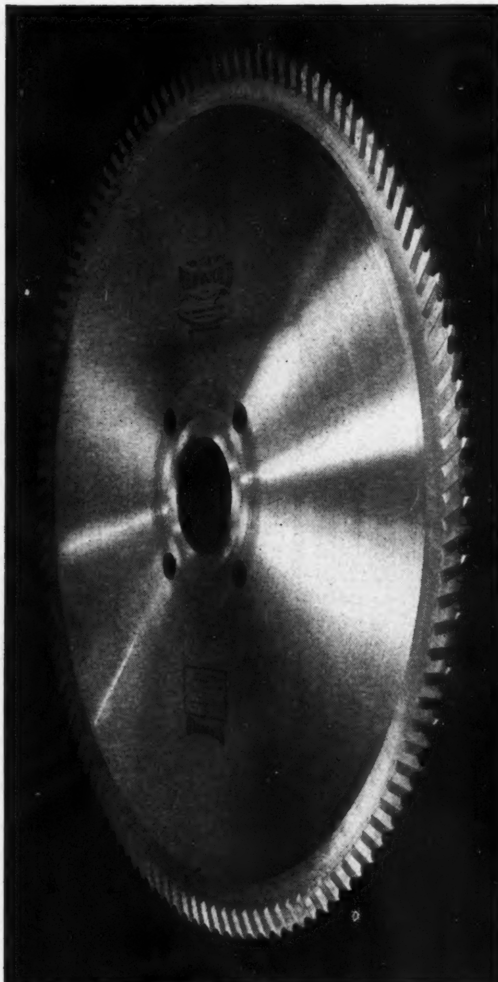

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MORE
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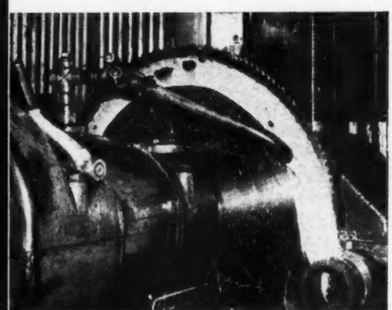


The NEWBOULD segmental saw

The scientific tooth design of the NEWBOULD segmental saw enables ferrous and non-ferrous metals to be cut at maximum feeds and speeds. Alternate roughing and finishing teeth produce free-curling, easily-cleared chips, reducing friction, minimising power wastage.
Made in sizes from 11″ to 60″ diameter with tooth segments of SABEN EXTRA high speed steel for maximum life between re-grinds.

Details on application.

SANDERSON BROTHERS AND NEWBOULD LIMITED

Attercliffe Steelworks, P.O. Box 6, Newhall Road, Sheffield 9.

KERRY

PILLAR DRILLS

These machines are renowned for their high standard of performance and dependability under the most arduous operating conditions to be found in industry today. Modestly priced, sturdily built and extremely versatile, they will give years of trouble-free service.

KERRY '100' POWER FEED PILLAR DRILL

A 1 inch capacity machine with nine speeds ranging from 70-1,500 r.p.m., a lever operated gear change with totally enclosed gear box and power feed, available with either a square or circular table.

KERRY '125' PILLAR DRILL

A 1¼ inch capacity, all-geared head machine, giving nine spindle speeds from 70-1,500 r.p.m. or 48-985 r.p.m., 3 rates of power feed reverse to spindle for tapping.

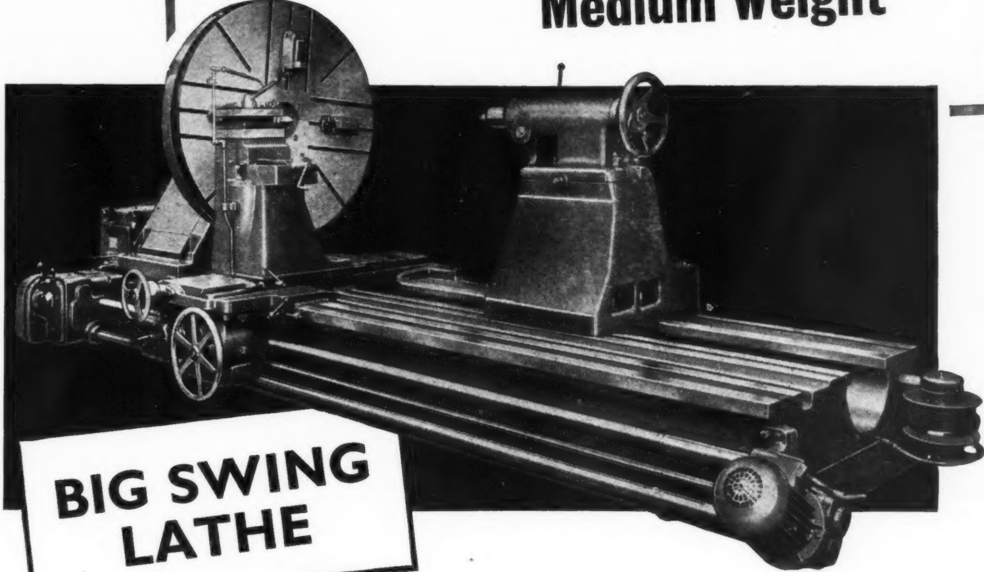
KERRY'S

manufactured within the KERRY GROUP by
KERRY'S (Engineering) CO. LTD
GRANGE ROAD, LEYTON, LONDON, E.10

A Kerry COMPANY

Sales Office: WARTON ROAD, STRATFORD, LONDON, E.15. Telephone: MARyland 6611

For Turning LARGE Diameter Drums and Rollers of Medium Weight



BIG SWING LATHE

The O & S Range also includes:

SS & SC lathes from 10½ in. to 24 in. capacity; surfacing and boring lathes up to 96 in. swing; break lathes; railway carriage and wagon wheel lathes; axle journal turning and burnishing lathes; straightening presses.

This lathe will swing up to 6 ft. over the saddle and is specially designed for Turning Drums, Rollers, etc. It is easy to handle, economical in operation and competitively priced. The Big Swing also makes this an ideal machine for general maintenance work.

The O & S Big Swing Lathe incorporates all these features:

- Up to 6 ft. swing over saddle
- Up to 25 ft. between centres
- 12 spindle speeds
- Large hollow spindle
- Spindle bearings PB or Taper Roller
- 32 enclosed change feed and screw-cutting box
- Long lead cutting gear
- Quick power motion to saddle
- Power feed to compound top slide if required
- Power feed to loose head-stock if required
- 30 or 35 H.P. motor drive

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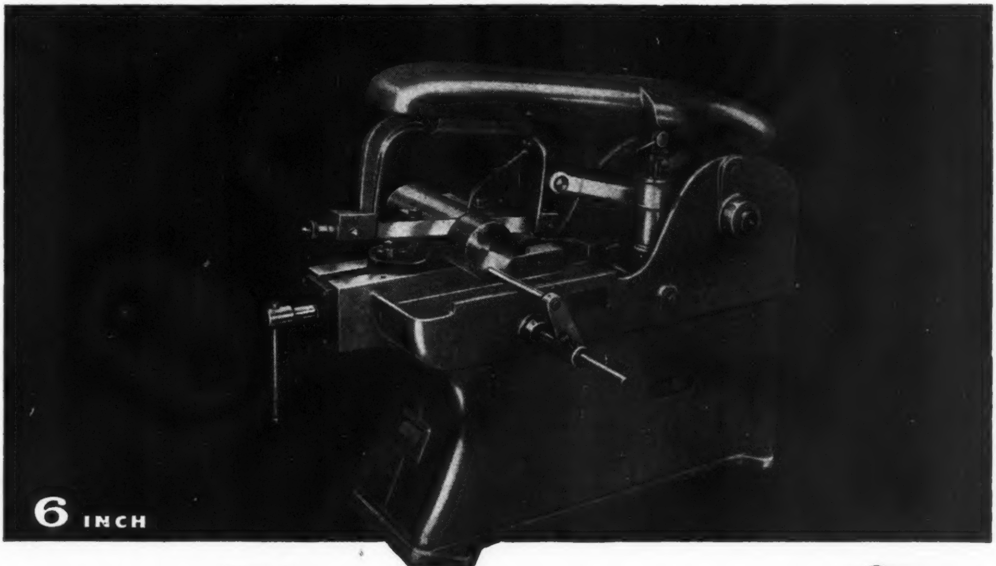

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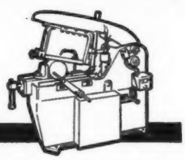

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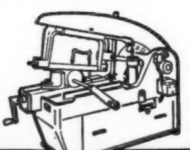

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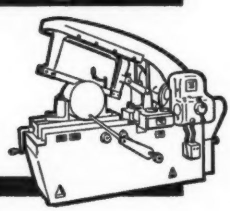

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Full details from your machine tool merchant or our Sales Office

The Famous Q&S

SAWMASTERS

are the finest HEAVY DUTY HACKSAWS in the world

Modern in design, robust and precise in construction, these unrivalled machine saws cut accurately and rapidly, and offer maximum production efficiency. Refinements include totally enclosed drive, hydraulic relief on the return stroke and automatic lifting of the bowslide to loading position on completion of cut.

Instant lever selection of correct cutting speed is a feature of all but the smallest model.

—and the famous SAWMASTER Autocut Power Bandsaw.

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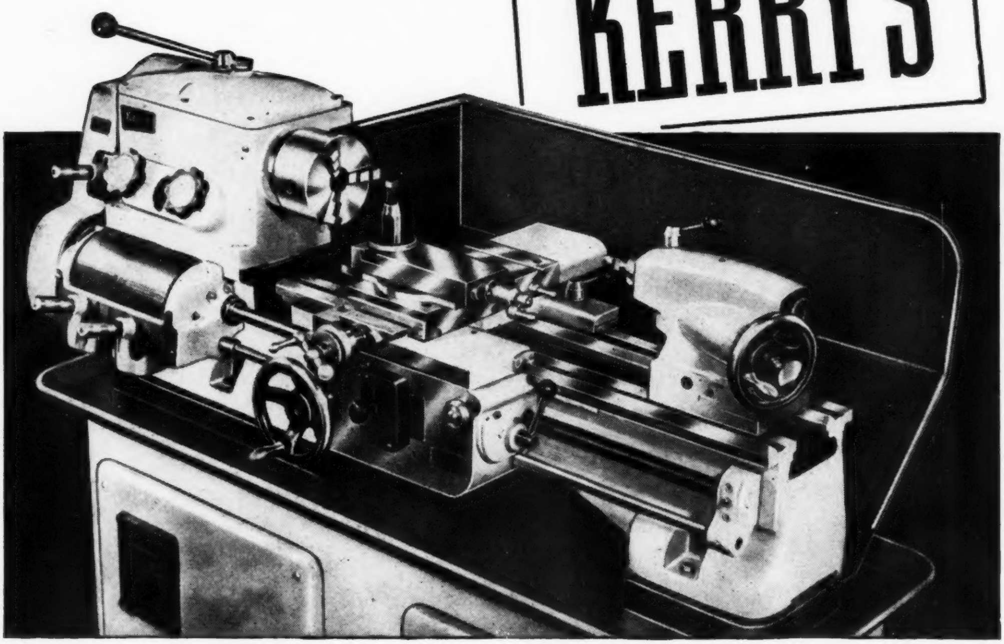
Broadway/Q&S

MORE AND MORE ARE TURNING TO KERRY'S



11" SWING LATHES

THOUSANDS in use in Great Britain and throughout the World!

- ★ SLIDING, SURFACING AND SCREWCUTTING LATHE
- ★ ALL GEARED HEADSTOCK GIVING 9 SPEEDS RANGING FROM 39-1500 r.p.m.
- ★ TYPE LOO PRECISION TAPERED SPINDLE NOSE
- ★ FEED BOX GIVES 62 PITCHES AND 7 FEEDS FROM ·0004 in.–·024 in.
- ★ CAMLOCK TAILSTOCK
- ★ BEDWAYS AND SLIDES PRECISION GROUND
- ★ HARDENED BEDWAYS OPTIONAL EXTRA

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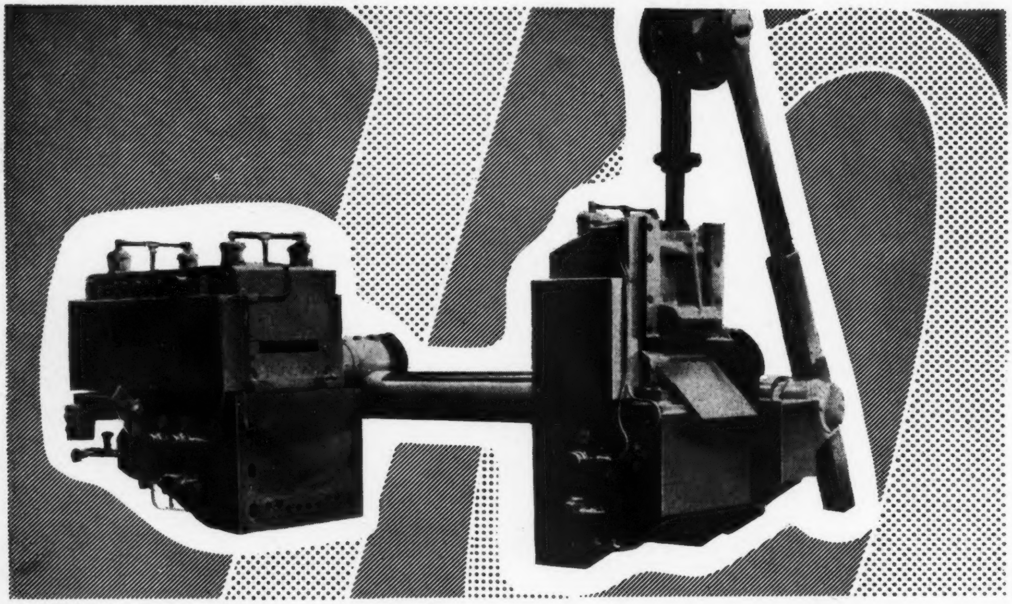
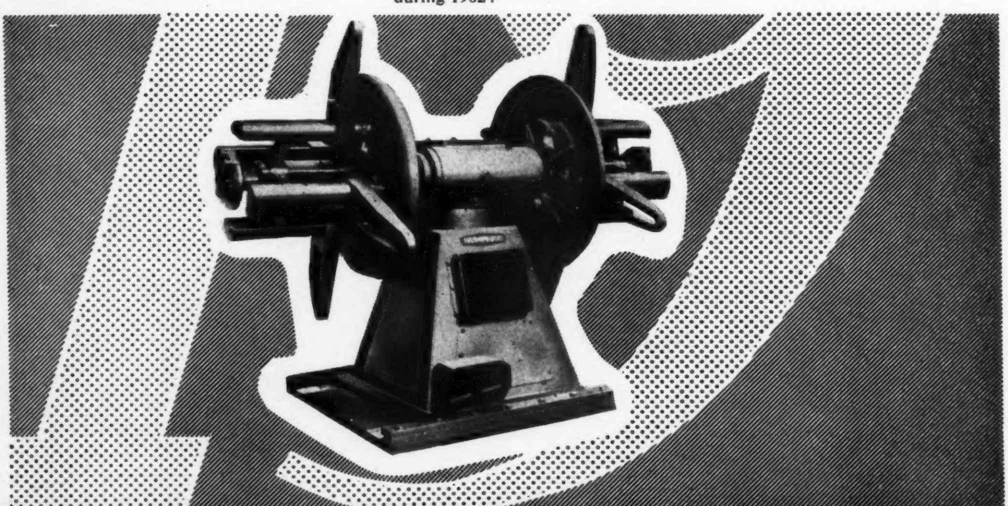


pressmaster

Each year HUMPHRIS make a serious contribution to the advance in the mechanisation of press shops. During 1961 significant progress has been made in the development of machines for handling thick, heavy strip. New decoiling, levelling and strip feeding machines have been introduced and electronically controlled cut to length lines further developed.

Why not make a point of enjoying the benefits of these technical advances during 1962?

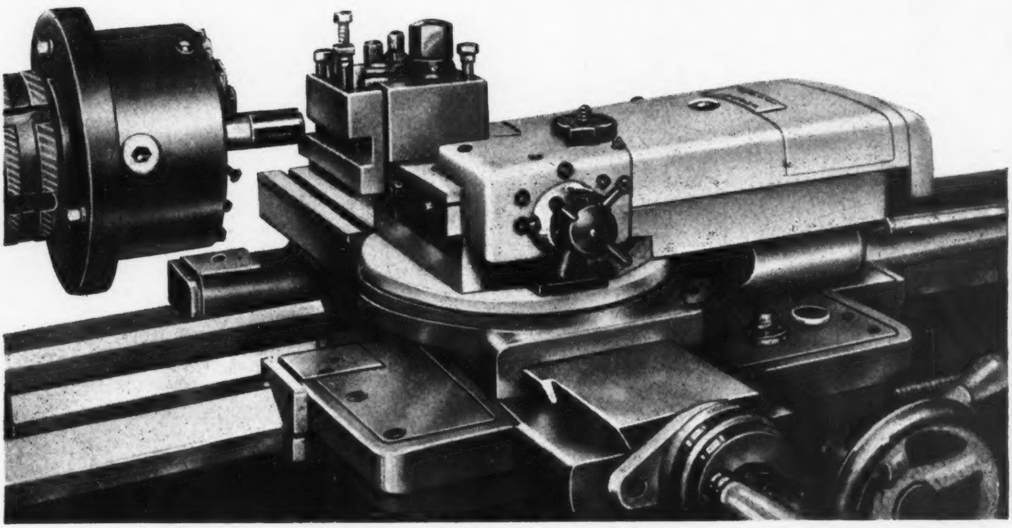


another year of continued


HUMPHRIS
progress at HUMPHRIS

FILEMATIC

high speed THREAD CUTTING ATTACHMENT



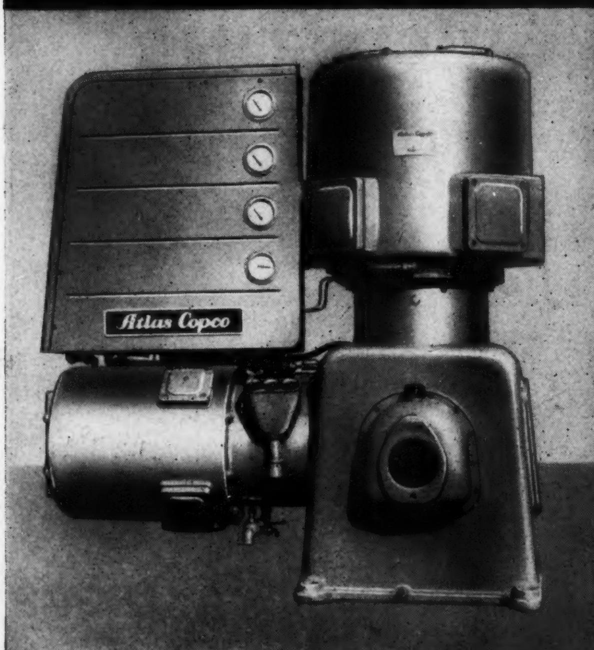
Write today for complete details of this revolutionary attachment

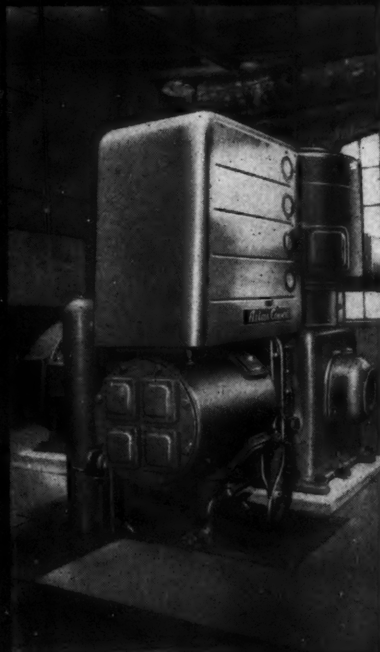
- FITS ANY CENTRE LATHE
- CUTS ANY THREAD... INTERNAL OR EXTERNAL CYLINDRICAL OR TAPER
- MAXIMUM LENGTH 1⅞in. MAXIMUM PITCH 5. T.P.I.
- THREAD RIGHT UP TO A SHOULDER... INSTANT WITHDRAWAL
- EQUALLY SUITABLE FOR SHORT RUNS OR LARGE SCALE PRODUCTION

HERBERT WIDDOWSON & SONS, LTD

CANAL STREET WORKS · NOTTINGHAM · ENGLAND

SKEFKO SAVE MONEY FOUR WAYS...





s/214

...with the Atlas Copco ER6

The Skefko Ball Bearing Company Ltd., has recently installed its seventh Atlas Copco stationary compressor–an ER6. Designed to incorporate *every* economy factor, the ER6 delivers 1075 c.f.m. at 100 p.s.i. for the lowest possible cost. Here's where some of the economies occur:—

1. INSTALLATION The ER6 occupies about half the space usually required for 1000 c.f.m. machines–reduces expensive compressor house costs. A special base frame can be supplied to keep erection and alignment costs to the minimum.

2. POWER CONSUMPTION 10-15% lower than that of most comparable compressors. Taking the lower figure, and presuming 4,000 working hours per year, this can mean annual savings of up to £360.

Side-by-side with two veterans The ER6 has been installed in the compressor house of Skefko's Luton plant alongside the first two Atlas Copco stationaries installed there. One of these has been in continuous, trouble-free service since 1932, the other since 1933. Progress in design and development is exemplified by the new ER6 which occupies less space than either of the other machines but delivers more air than both of them put together!

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Sales and Service Depots at: LONDON · BRISTOL · CARDIFF · LICHFIELD
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Atlas Copco

puts compressed air
to work for the world

GIDDINGS & LEWIS

Horizontal BORING, DRILLING & MILLING Machines

Now British Built

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Close tolerances required in Milling, Boring, Drilling and Tapping 'U.S.' MULTISLIDE Beds are maintained on Model T5 machine at ALLTOOL LTD., Brentford.

4″ DIA. SPINDLE (20 H.P. MOTOR) OR 5″ DIA. SPINDLE (25 H.P. MOTOR)

LONG LASTING JIG BORING ACCURACY

AMPLE POWER FOR HEAVY DUTY MILLING

WIDE CHOICE OF TABLE, BED AND COLUMN SIZES

WIDE RANGE OF SPEEDS AND FEEDS

UNEQUALLED MACHINING VERSATILITY

DIRECT READINGS TO 0·001″ OF HEADSTOCK AND TABLE SETTINGS

BRIEF SPECIFICATIONS

Model	T4	T5
Diameter of spindle	4″	5″
Spindle motor	20 h.p.	25 h.p.
Spindle speeds (45)	10-1300 r.p.m.	7·5-975 r.p.m.
Max. table cross travel	132″	132″

EQUIPMENT AVAILABLE includes

EXTENDED SADDLE AND SADDLE SUPPORTS with in- or over-the-floor type auxiliary runways.

IMPROVED MEASURING DEVICE giving readings to 0·0001″.

AUTOMATIC ELECTRIC POSITIONING—positive settings within 0·0002″.

HEAVY DUTY ANGULAR MILLING ATTACHMENTS.

CONTINUOUS FEED FACING AND BORING HEADS.

Many types of AUXILIARY and BUILT-IN ROTARY TABLES.

DAVIS SUPER MICROMETER STUB BORING TOOL SETS.

ROCKWELL
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WERNER the **Standard** Milling Machines with the standard features which are extra on competitive makes.

WERNER the **Standard** Milling Machines with practical features unobtainable on other makes, e.g. directional finger tip switches controlling all table and knee movements, automatic hydraulic clamping of slides.

WERNER the only **Standard** Milling Machines with automatic table cycles at no extra cost.

WERNER **Standard** Milling Machines are built with table sizes up to 98″ x 24″ with 67″ travel.

WERNER **Standard** Milling Machines are available in horizontal, universal and vertical types.

WERNER **Standard** Milling Machines have so many EXTRA features.

WERNER

—the most advanced STANDARD MILLING MACHINES built AND

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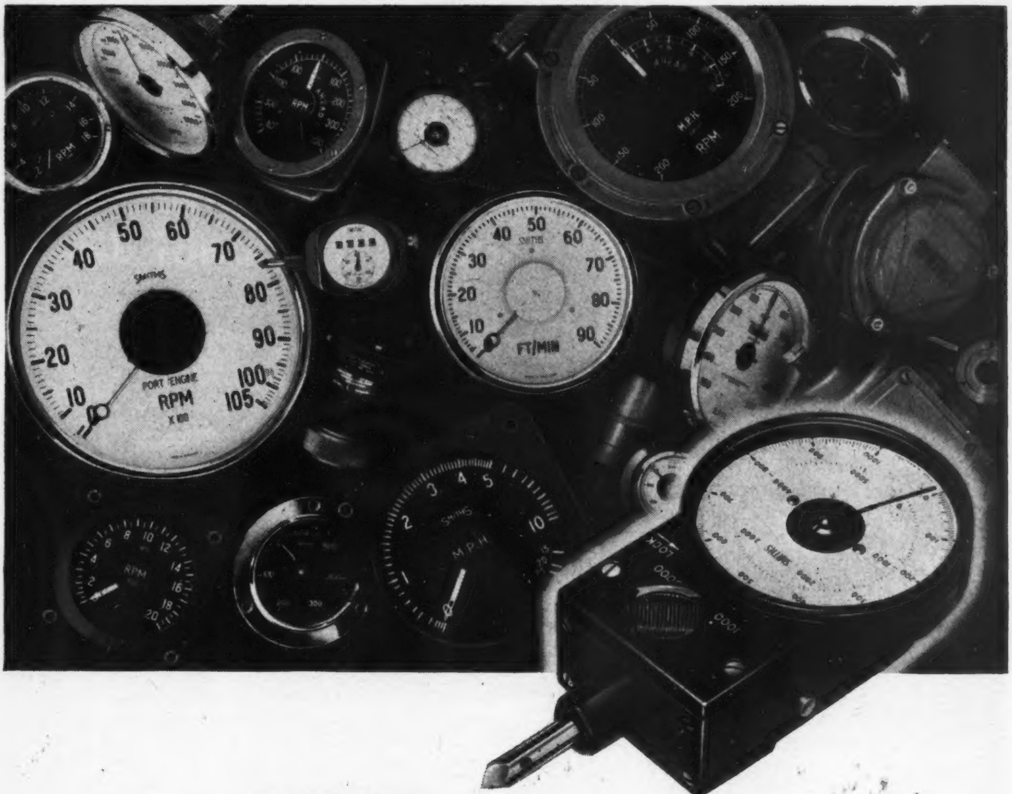

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Wherever the measurement and direct or remote indication of rotary or linear movement is required, SMITHS Industrial Division can provide the instrument for the specific task. Such diverse functions as cutting speeds, conveyor speeds, rate of printing impressions, baking times, speed and distance for road surface dressing, and innumerable others are reliably indicated on the dial of the appropriate SMITHS instrument. Inset above is the SMITHS Hand Tachometer — an extremely robust precision instrument for checking rotary, linear or surface speeds, even in awkward places. Whatever your indicating problem, dial SMITHS at Wembley 8888 — we'll gladly be instrumental in solving it.

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The Industrial Division of **S. Smith & Sons (England) Ltd**

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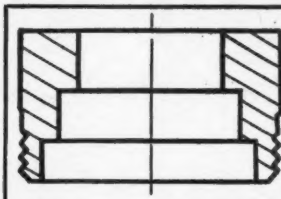
Yet another example of PRODUCTIVITY!

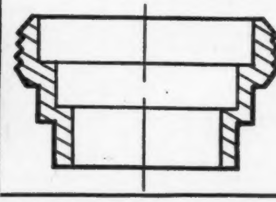
KUMMER

There are many operations where the Kummer K20 can show handsome savings. This is one of many typical examples. Suitable for work on bar, castings, forgings and stampings.



Operation 1
Loading 6 secs
Machining 28 secs
Material—BRASS (Billet)

SCALE FULL SIZE



Operation 2
Loading 6 secs
Machining 43 secs
Material—BRASS pre-machined blank from Op. 1.

K20 Semi-Automatic Twin-Head PRECISION LATHE...

- Work head spindle can automatically operate at high or low speeds according to preselected cutting speeds.
- Camshaft driven from main spindle.
- Cam accelerator reduces machining cycle time.
- Air-operated chucking.
- Spindle positioning device for irregular shaped components.
- Easy loading of components into chucks.
- Write for full data.

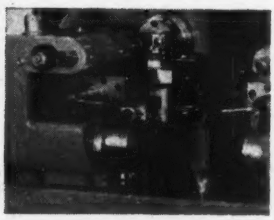


Illustration shows tailstock which is one of the many optional features available.

GASTON E. MARBAIX LTD.

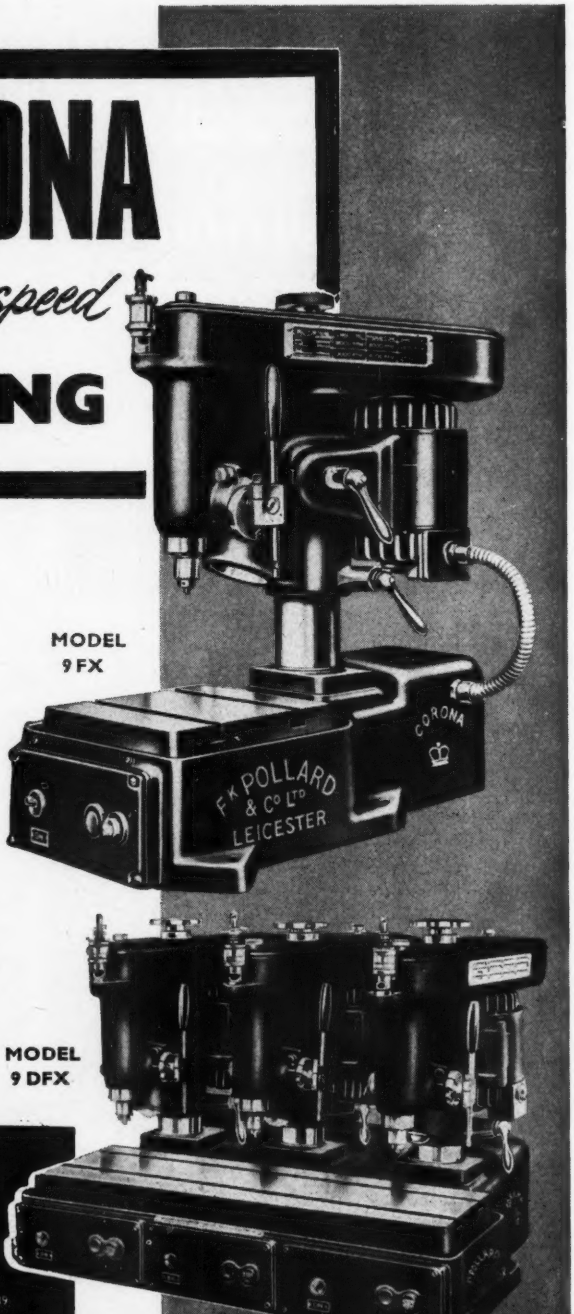
Devonshire House, Vicarage Crescent, Battersea, S.W.11. Phone: Battersea 8888 (8 lines)

NRP 3424

CORONA

for super high speed

DRILLING



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Up to 18,000 r. p. m.
on continuous duty

MODEL
9 FX

These super high speed sensitive drilling machines, built with from one to four spindles, have been specially designed for high speed operation. Drilling capacity is 5/32 in. dia., in mild steel. Distance from column to spindle 4½in. Maximum distance between chuck and table is 4⅛in., with vertical adjustment of 3in., and spindle traverse of 1½in.

MODEL
9 DFX

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& CO. LTD.

CORONA WORKS, LEICESTER, ENGLAND
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London office: COASTAL CHAMBERS, 15 ELIZABETH ST., BUCKINGHAM PALACE RD., S.W.1. TEL: SLOANE 8880
Scottish Representatives: WALTER S. LANG & CO., 48 OSWALD STREET, GLASGOW, C.1. Tel: CENTRAL 2539
North East: HODSON MACHINE TOOLS LTD., 150 NEW BRIDGE STREET, NEWCASTLE-UPON-TYNE

SAVE FLOOR SPACE CUT PRODUCTION TIMES IMPROVE SURFACE FINISH

With these latest additions to the ewall-Keighley range of competitively priced, high precision cylindrical grinders.

SERIES L4 and L6

Features:

- Capacity between centres—18 inches (18 or 24 inches in type L6), maximum grinding diameter—6 inches.
- Compactness—self-contained unit reduces space requirements to a minimum.
- Fully hydraulic operation of wheelhead and table movement.
- Unit construction of hydraulic control panel simplifies operation and aids servicing.
- Built to give toolroom tolerances and superior component finish under exacting production conditions.
- Hydraulic wheelhead—mounted dresser or internal grinding head included in wide range of optional equipment.

SERIES L6
Angle Head Grinder

his high production machine with 45° angle head r grinding an external diameter and adjacent face of a component from one setting has an extensive eld of application in modern engineering practice. Built to the same sturdy proportions as the plain grinder illustrated above and with similar features, it is offered with a apacity of 18 inches or 24 inches between centres d will grind components up to 6 inches diameter.

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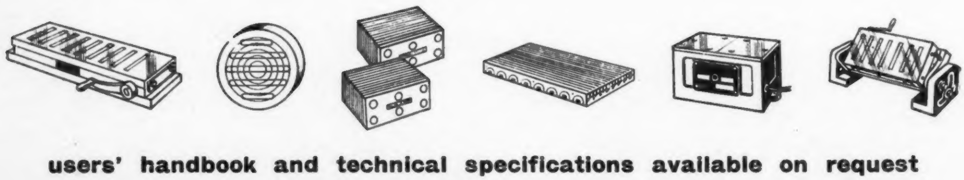

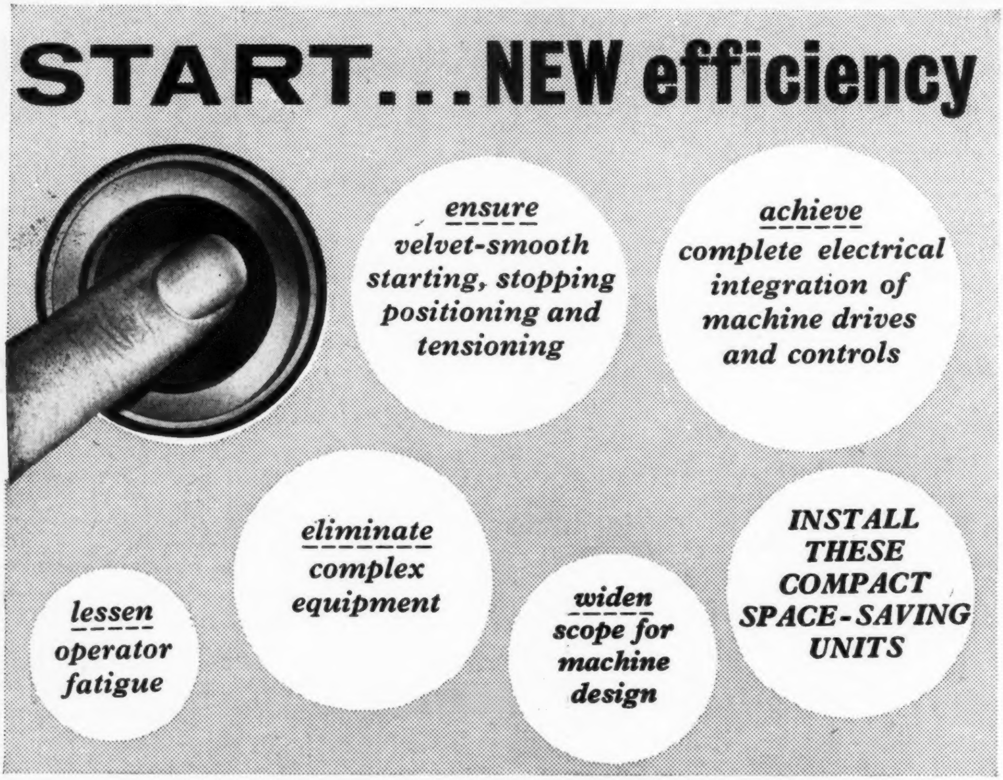

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Electric Brakes and Clutches

MORE CONTROL—MORE PRODUCTION

Warner *Electric* Brakes and Clutches completely integrate power transmission with electrical or electronic machine control circuits. Electric Brake units eliminate coasting, save non-productive machine time; electric clutches operate rapidly in any position and give smooth engagement. Warner electric units are easily installed—on new or old-type machines. Their superior performance is directly responsible for greater production in many varied industries very—probably in yours !

Write for illustrated Warner brochure

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WHO PUT THE PNEU IN PNEU-MATICS?

It was Martonair who successfully harnessed the PNEU. PNEUS have, of course, existed from the very dawn of time, but it took Martonair to realise their immense potential as a power medium for industry

Only in recent years has PNEU-matics come into its own. During these years of development, Martonair have been the acknowledged leaders of the field, training very large numbers of PNEUS. Today the demand is greater than ever before, and fully-trained PNEUS are now leaving Martonair factories in their hundreds every day, finding their way into every branch of industry. Every conceivable type of PNEU—long, short, large, small—for duty in production processes.

Make it your business to know more about the PNEUS.

Martonair

Further informatic on every aspect of Applied PNEU-matics is available from:

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PNEUS are available from Martonair in Australia, Belgium, Canada, Denmark, Finland, France, Germany, Holland, Italy, New Zealand, Norway, South Africa, Spain, Sweden, Switzerland, U.S.A., and are exported to all parts of the world

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99 years of REXITE Service

TO USERS OF GRINDING WHEELS •

GRINDING WHEELS AND SEGMENTS FOR ALL PURPOSES

VITRIFIED AND RESINOID BONDS

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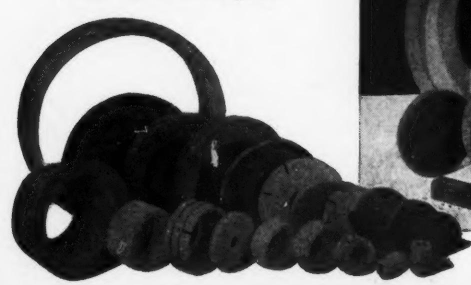

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MITCHELLS GRINDING WHEEL CO. LTD.

EST. 1862

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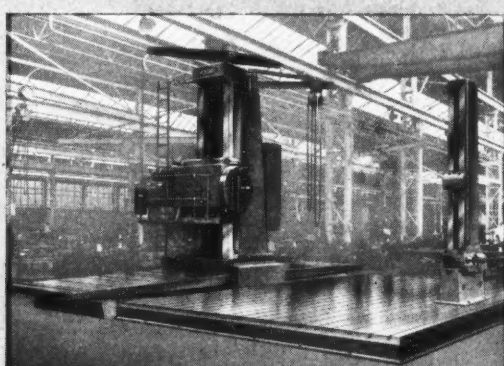
The Sand Martin (COTILE RIPARIA) is a summer visitor to the British Isles less familiar than the Swallow and House Martin, being a rarer bird and preferring a habitat remote from that of man. The nest it builds is a slight affair of grass and feathers deposited at the end of a gallery bored in a sandy bank. Although ill equipped for boring, the Sand Martin makes a speedy job of the business and the tunnel, which has a slight upward tilt for drainage, can be anything up to nine feet long.

The Cotile Riparia is efficient. . . but hardly a

PRECISION BORER

HORIZONTAL and VERTICAL BORERS produced by GEORGE RICHARDS & CO. LTD., however, are unsurpassed for precision, speed and adaptability. Continuous research and development keep RICHARDS borers way ahead of all others.

Illustrated right is the Richards "ELECTRABORE" Travelling Column Floor type Horizontal Boring, Facing, Milling, Drilling and Tapping machine, supplied with or without traversing spindles from $3\frac{1}{2}''$ to $8''$ diameter. A power operated rotary type table can be supplied.



GEORGE RICHARDS & CO. LTD.

BROADHEATH-ALTRINCHAM-CHESHIRE

Sole Agents: ALFRED HERBERT LTD., FACTORED DIVISION, COVENTRY

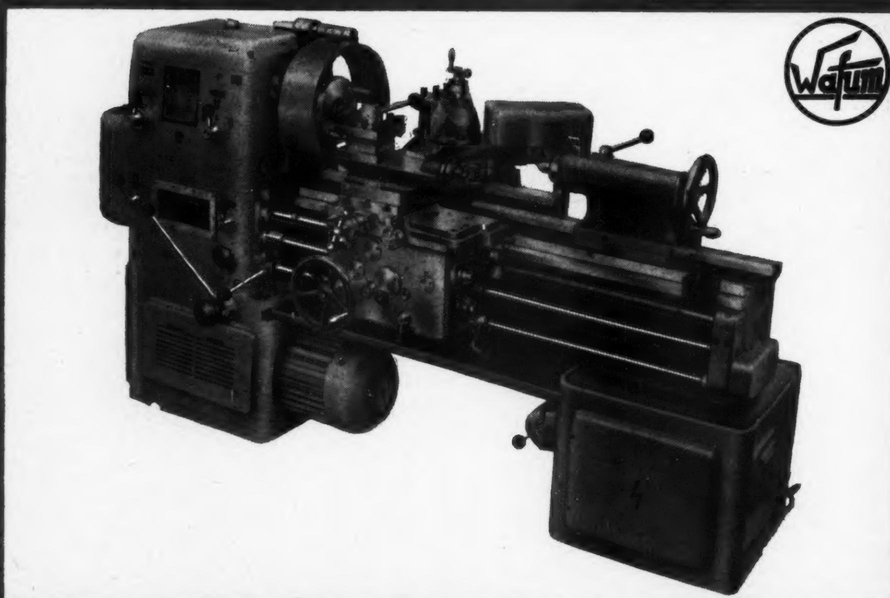
NEW HIGH-SPEED UNIVERSAL LATHES

- Rigid structure
- Spindle speed preselection
- Reduced set-up times
- Self-acting motor braking at speed reversal
- Unloaded spindle
- Large range of feeds and thread pitches—inch, metric, module and D.P. threads
- Hydraulic copying attachment and other items of the special equipment on request

TUC 40
TUC 50

SPECIFICATION:

	TUC 40	TUC 50
Swing over saddle	8$\frac{7}{8}$in.	12$\frac{7}{8}$in.
Swing over bed	15$\frac{3}{4}$in.	19$\frac{11}{16}$in.
Turning length	39$\frac{3}{8}$in.—59$\frac{1}{16}$in.—78$\frac{3}{4}$in.	39$\frac{3}{8}$in.—59$\frac{1}{16}$in.—78$\frac{3}{4}$in.
18 spindle speeds within the range of	28–1,400 r.p.m.	28–1,400 r.p.m.
84 longitudinal feed rates within the range of...	0·003—1 1/32in./rev.	0·003—1 1/32in./rev.
84 cross feed rates within the range of	0·0015—33/64 in./rev.	0·0015—33/64 in./rev.
Motor power	9·4 H.P.	9·4 H.P.



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METALEXPORT
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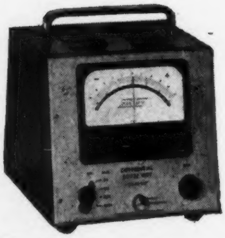

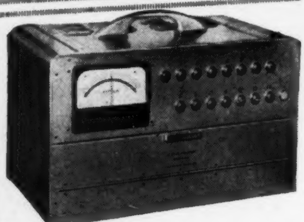

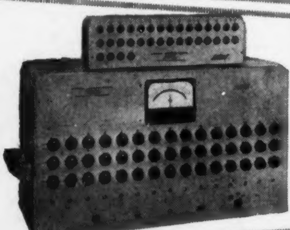

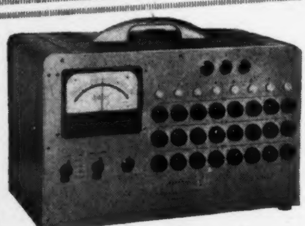

Because PARNUM equipment measures down to ·00001in., don't get the idea it's not for you. All the basic units are both super-sensitive and coarse—in fact, we put four ranges on them to cover all your requirements. And whether you are measuring 'hundredths' or 'thous', unskilled operation is just as easy.

For fast unskilled tolerance checking, the Gauge-light unit shown above is the answer. The operator merely watches the coloured lights.

GAUGE-LIGHT UNIT COMPLETE WITH PROBE ... ... £122·10·0

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PARNUM GAUGES LTD., BRACKNELL. BERKS
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ACCURATELY YOURS—

PARNUM GAUGING EQUIPMENT

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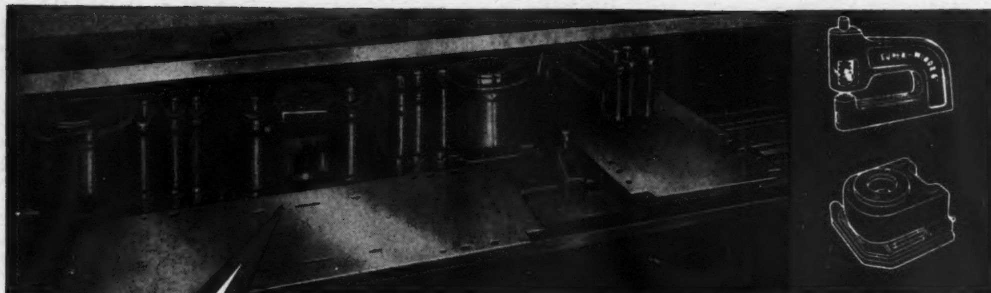

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UNITOOL SYSTEM

Patent Nos. 639079 & 647163

TRANSFER PRODUCTION ON ANY PRESS OR PRESS BRAKE WITH LOW COST!

Standard UNiPIERCE and UNiCROP Units cut the cost of tooling and get you into production faster.

At a fraction of the usual cost our standardised units make possible multi-operation transfer work on all types of Presses and Press Brakes. Full details and technical help without obligation. Catalogue UP/1002/M4 on request.

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Tel: Worcester 26933 (6 lines) Telex 33594 'Grams: Redtools, Worcester. Northern Agents: Dunmac Ltd., 123 Hope Street, Glasgow C.2. Tel: Central 0421/2.

It's a fine thing!

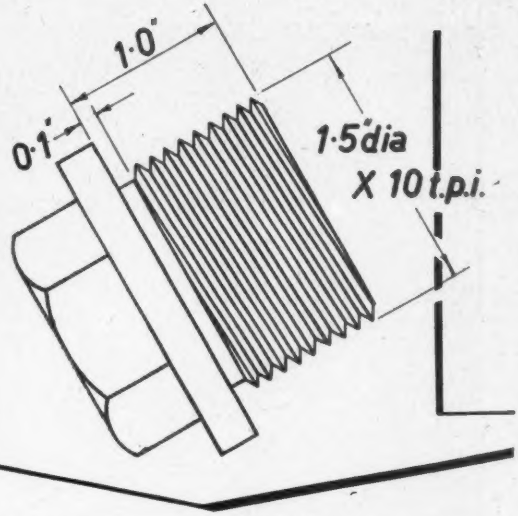
In fact the finer the tolerance, the greater your confidence in the precise, accurate measurement of your Shardlow Micrometer. Constant attention to engineers' problems the world over, has brought about refinements making the Shardlow Micrometer even more accurate and easy to read. This is featured in the Oblique Line Sleeve, which eliminates line reading errors of .025" (.5mm), and can be specified, at no extra cost, when ordering an Internal or an External Micrometer, but be sure it's a Shardlow—

—a very fine thing indeed!

SHARDLOW MICROMETERS LIMITED PETRE STREET · SHEFFIELD 4

Phone: 386951/2 Grams: MICROMETERS SHEFFIELD

Could you screwcut this 'Nimonic 80' component in 25 secs. on a centre lathe?

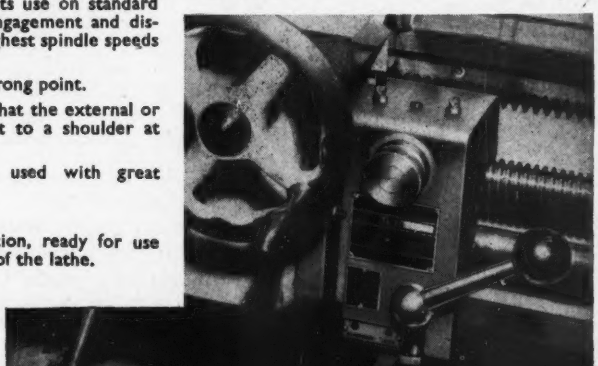


The answer is 'yes' if you fit an 'AINJEST' high speed screwcutting attachment!

For 1 off and upwards
Toolroom or Production — setting time is negligible.

In the same way that the chasing dial has superseded the old method of marking chuck, headstock, leadscrew collar and bracket; the AINJEST HIGH SPEED SCREWCUTTING ATTACHMENT has established a further major advance in screwcutting techniques. Its use on standard centre lathes allows the automatic engagement and disengagement of the leadscrew at the highest spindle speeds of which the machine is capable.

- ★ The cut cannot be started at the wrong point.
- ★ The cut is stopped accurately so that the external or internal threads can be cut tight to a shoulder at high speeds.
- ★ Tungsten carbide tools can be used with great advantage.
- ★ Chasing dial is eliminated.
- ★ The attachment remains in position, ready for use without restricting the versatility of the lathe.



AINJEST *High speed* **SCREWCUTTING ATTACHMENT**

● *stockists of* **"KENNET"** *carbide threading and turning tools*

Write for details and prices to Dept. A.S.C

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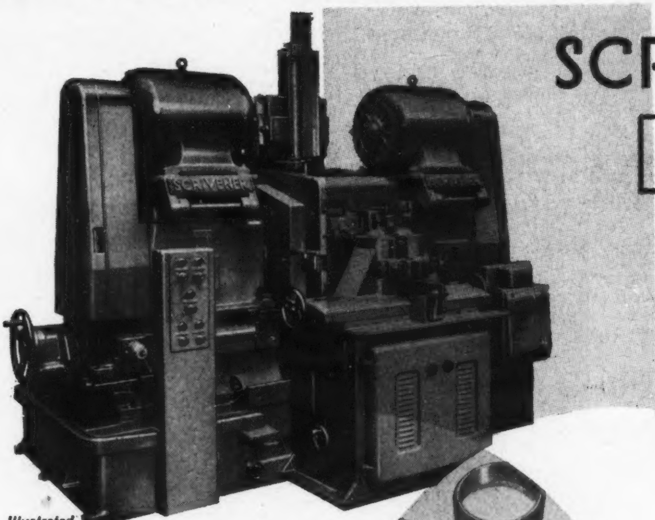
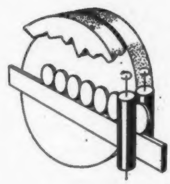
SCRIVENER

Duplex

Face Grinding Machine

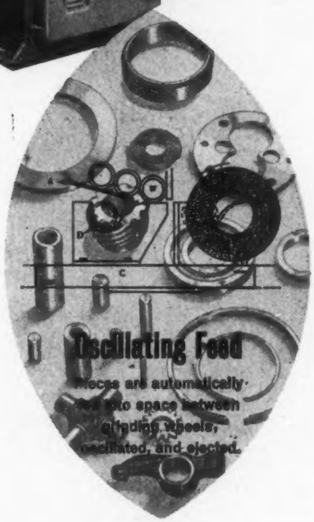


Illustrated Scrivener 24/30



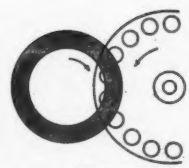
Roller Feed

Flat work-pieces capable of being rolled are best fed between vertical pressure rollers.



Oscillating Feed

Pieces are automatically fed into space between grinding wheels, oscillated, and ejected.



Rotary Feed

Irregular flat pieces which will not roll or slide can be handled by a rotary feeder.

The Scrivener 24/30 Duplex Face Grinding Machine employs the principle of mounting two large grinding wheels on horizontal spindles, with their cutting faces parallel so that workpieces passed between them have their opposite faces ground simultaneously.

This machine is designed to deal with the wide range of duplex grinding applications which exist in the engineering and other industries where components require grinding on two flat opposing surfaces to close limits of accuracy.

Typical components are:

Automobile Industry — — Piston Rings, Brake Discs, Cylinder Heads.

General Engineering — — Spacing Washers, Roller Bearing Rings, Sleeves.

Electrical Industry — — Insulators, Spacers, Condenser Parts.

Plastics Industry — Ebonite Meter Discs, Pump Discs.

Write to Wickman Ltd., for a copy of the Scrivener 24/30 Catalogue giving full details and specifications.

WICKMAN LIMITED

FACTORED MACHINE TOOL DIVISION, FLETCHAMSTEAD HIGHWAY, COVENTRY. Tel: 74321

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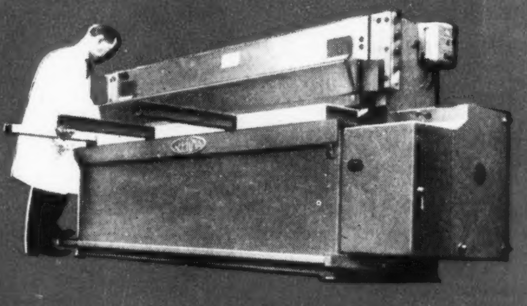
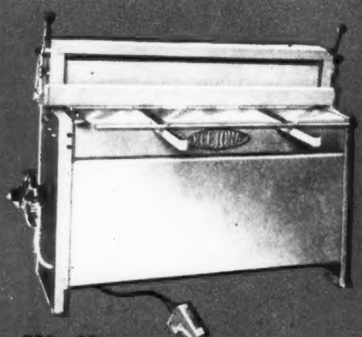
Shears and Bending Rolls

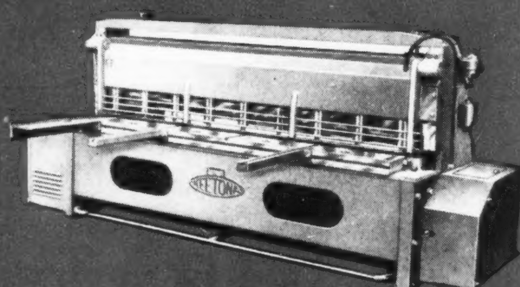
Streamlined design and fabricated steel construction are two of the outstanding features of Keetona Sheet Metal Working Machines. The examples shown here give some idea of the wide range we make—please write for full information. Hire purchase terms available.



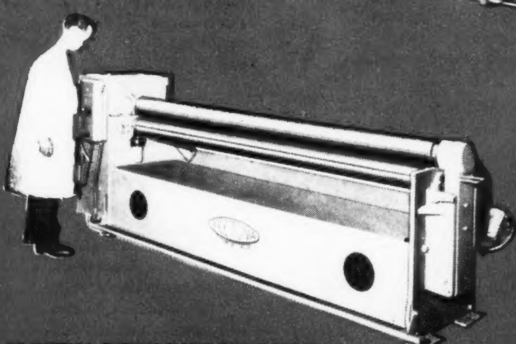
78" x 10 ga. SHEAR



50" x 16 ga.
AIR OPERATED SHEAR



96" x 1/4" SHEAR
There is a full range of Keetona Shears in capacities from 40" x 18 ga. to 120" x 1/4"



6" INITIAL PINCH BENDING ROLLS
from 48" x 3/16" to 120" x 14 ga.

ALSO PYRAMID BENDING ROLLS
from 72" x 1/4" to 120" x 1/2"

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KEETONA WORKS, GREENLAND ROAD, SHEFFIELD, 9. TEL: SHEFFIELD 42961/4.

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Fitted as Standard Equipment

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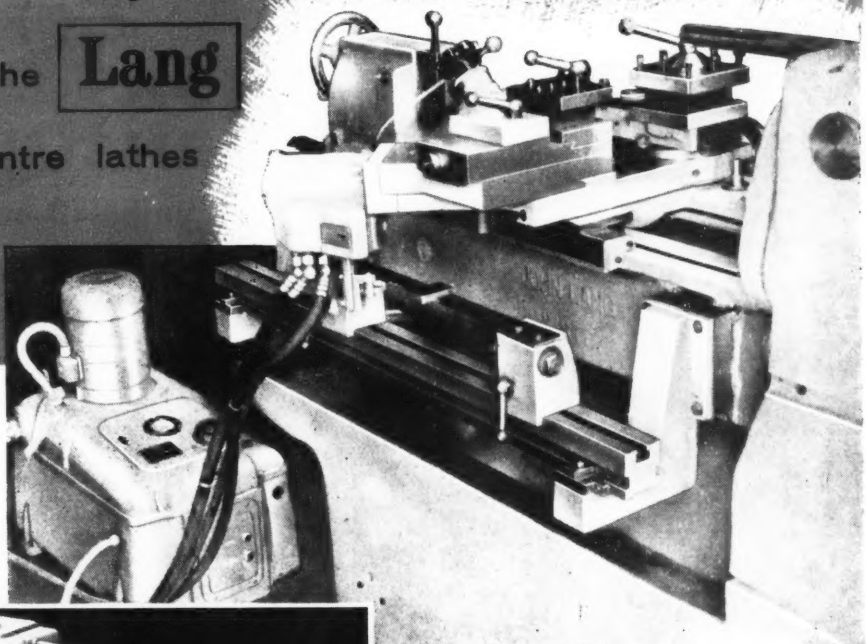
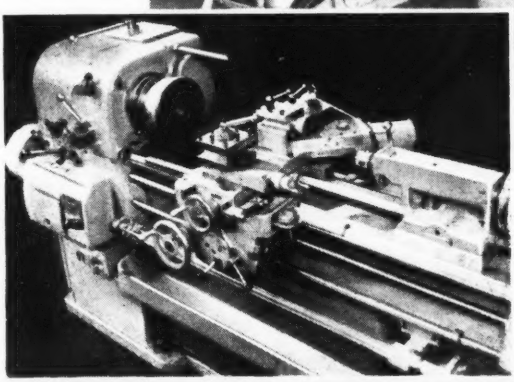
hydraulic copying equipments

... to the **Lang**

13" centre lathes





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Entirely self-contained and does not impede the normal use of the lathe in any way.

Fine tapers and radii readily copied and close tolerances maintained.

Machining times on complicated shapes greatly reduced.

A FULL RANGE OF UNITS IS AVAILABLE SUITABLE FOR PLANERS, VERTICAL BORES, VERTICAL MILLING MACHINES ETC., ETC. ASK FOR COMPLETE DETAILS.

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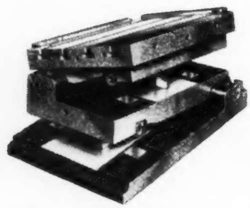

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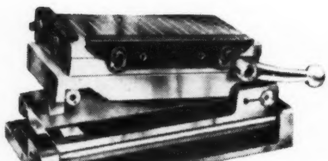

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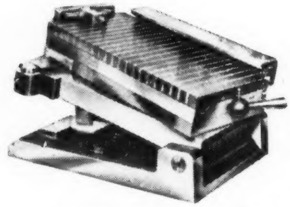

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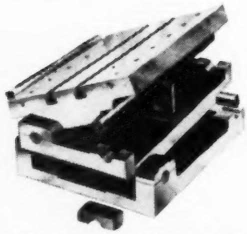

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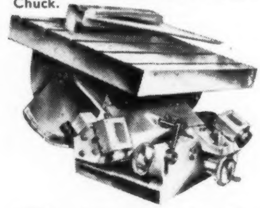

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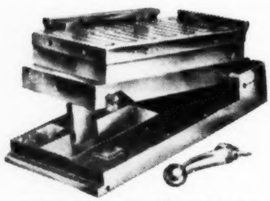

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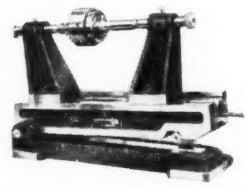

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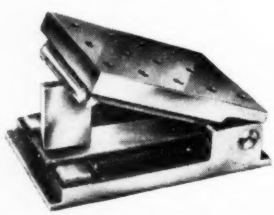

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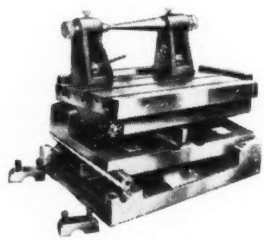

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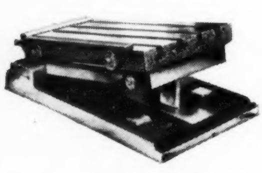

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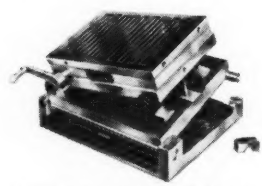

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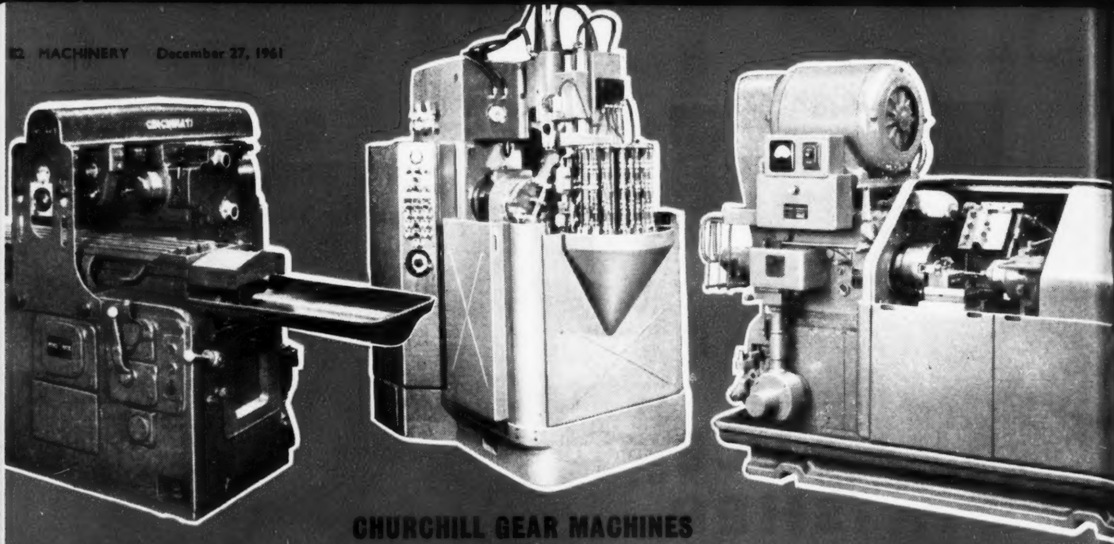

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Abstracts of Principal Articles

Producing the C.A.V. Type DPA Diesel Fuel Distributor Pump .. .. P. 1468

The third in a series, this article deals with selected operations on cam rings and roller shoes for DPA pumps. A link-line is installed for producing cam rings, incorporating a Tavannes Gyromatic vertical automatic, a Diskus Werke twin-head face grinding machine, a British-built "American" vertical broaching machine, a Sundstrand automatic lathe, a Steinel special-purpose drilling, milling, chamfering and tapping machine, and a Funditor roll marking machine. Subsequently, the cam profiles in the bores of the rings are ground on a battery of special Keighley machines, and inspection is facilitated by the provision of O.M.T. optical equipment, specially designed for the company. Selected operations on roller shoes are described, including side-grinding operations on ten at a time on a duplex machine. The arcuate portions at the ends of the shoes are finished on a Keighley machine with a V-section wheel, and a simple fixture holds five workpieces at a time. Finally, the roller seats are finish ground on special Mollart machines which generate the part-cylindrical surfaces by combined rotation of the work and oscillation of the grinding spindle. (MACHINERY, 99—27/12/61.)

The R.A.E. Efflux Drive System .. P. 1478

The drive system here described is intended for continuous-control machine tool duties where the machining reaction forces are not high, for example, finish grinding, chemical milling, flame-cutting and inspection. A sliding member is designed to incorporate special pockets, which are open at one end, and a propulsive thrust is produced by introducing pressure oil into the pockets and allowing it to escape from the open ends. A rig is described in which the system is used in conjunction with moiré fringe equipment, for accurate positioning. (MACHINERY, 99—27/12/61.)

Operations on Components for Littlejohn Missiles .. .. P. 1480

Examples of practice at the Consolidated Western Steel Division of United States Steel Corporation, Los Angeles, Calif., U.S.A., are here considered, in connection with producing components for the Littlejohn ballistic missile. Forged blanks for motor cases are turned on 6-spindle vertical chucking automatics in preparation for subsequent flow turning operations. Flow turning is carried out by the multi-pass method, and the resultant cold-working of the material eliminates the need for heat-treatment. A special lathe is employed for contour-turning the forward end of the case, also for trimming it to length, and another special lathe is installed for operations on the aft end, also for semi-finishing seats for anti-friction bearings. Submerged-arc seam-welding is used for joining a "pedestal" to the case, and a special double-ended machine provides for multiple drilling and tapping operations. A number of operations on the rocket nozzle is described, including boring on a special automatic machine. (MACHINERY, 99—27/12/61.)

Thomas Ryder & Son, Ltd., Turner Bridge Works, Bolton .. .. .. P. 1485

The firm that bears his name was founded by Thomas Ryder in 1865, initially for the production of textile rollers. Since the company built many of its own machines, it turned to the building of machine tools when trade in textile equipment slackened. Many types of machine tools were produced, but lathes preponderated, and separate workshops for machine tool building were constructed in 1900. After the first world war it was decided to build more specialized machines, and the first vertical chucking automatic was exhibited at Olympia in 1924. Improved designs followed regularly, and the company now builds three sizes, with numbers of spindles up to 12. (MACHINERY, 99—27/12/61.)

Analysis of Metal Flow in Die Casting Dies .. .. P. 1501

Recent advances in pressure die casting, and the increasing tendency in the motor vehicle industry to demand larger castings of thinner sections have emphasized the critical influence of metal flow within the cavity upon the quality of the casting. In this reprint of a paper delivered by Dr. A. I. Veinik before a conference of the Association of Foundry Technicians (VNITOL) the influence of thermal factors in die casting is examined exhaustively. In the author's opinion, such factors are of prime importance, and this contention is supported by an impressive array of mathematical proof. (MACHINERY, 99—27/12/61.)

IN FORTHCOMING ISSUES

The production of business machine components—Automatic loading arrangements on Nickols air-operated capstan lathes—Mitsui leadscrew measuring machine.

Contributions to MACHINERY

If you know of a more efficient way of designing a tool, gauge, fixture, or mechanism, machining or forming a metal component, heat treating, plating or enamelling, handling parts or material, building up an assembly, utilizing supplies, or laying out or organizing a department or a factory, send it to the Editor. Short comments upon published articles and letters on subjects concerning the metal-working industries are particularly welcome. Payment will be made for exclusive contributions.

EDITORIAL

The Possibilities of Hot Machining

Despite the remarkable advances that have taken place in recent years in connection with cutting tool materials, considerable difficulties are experienced in machining, by orthodox methods, some of the metals and alloys that are now available. In particular, serious problems may arise in connection with work materials of very high tensile strength, especially if strength is retained to a comparatively high degree at elevated temperatures. Application of such metals and alloys is, of course, largely confined at present to components for gas turbine and rocket propulsion units, and for the structures of high speed aircraft and missiles. Although the cost of these materials is generally high, however, it is likely that advantage of their special properties will be taken in the future for an increasing variety of purposes, provided that the expense of machining and other production processes is not excessive. It follows that methods of working these high strength, heat-resistant, metals and alloys are likely to become of wider interest to production engineers, and hot machining appears to provide one of the most promising lines of approach.

As was pointed out in a paper by Mr. J. L. Wennberg, Mr. C. L. Mehl, and Mr. E. J. Krabacher, read before the American Society of Automotive Engineers, the idea of heating metal to facilitate machining is by no means new. Considerable research was carried out in connection with this technique some years ago and various papers were published in which attention was drawn to the important potentialities from the standpoints of tool life and productivity. Subsequently, however, interest lapsed, and hot machining processes found little practical application, partly, it is suggested, because the methods of heating then available were not very effective, and partly because the operations involved were not sufficiently severe to justify the added complication.

With the introduction of the so-called refractory metals, however, it became expedient to carry out further investigations, and this work has been sponsored by the Manufacturing Materials Technology Division, AMC Aeronautical Systems Centre, of the U.S. Air Force.

It is explained by the authors of the paper that whereas previous heating of the work material may have the effect of increasing the temperature at the tool-chip interface and consequently reducing the ability of the tool to resist abrasion, it may simultaneously reduce the ability of the chip to abrade. Heating may therefore have the effect of either increasing or reducing tool life depending upon the relationship between these factors. For obvious reasons preference is given to carbide or ceramic tools where heated work material is to be machined.

Tests which were carried out on four different materials, each at two different hardnesses, showed that an increase of workpiece temperature of 1,000 deg. F. had the effect of reducing the cutting force on the tool by 40 to 50 per cent and the thrust force by 33 to 66 per cent. In this connection it should be noted that a reduction of the forces on the tool may not only result in increased life, but may facilitate the design of the fixture required to hold the workpiece. Of more direct interest, however, are the comparative figures for tool life. Turning tests were carried out on various materials, including 4340 steel and Thermold J hot working die steel, both at a hardness of 600 Brinell, and it was found that by raising the workpiece temperature to 800 or 900 deg. F., tool life, at constant cutting speed, was increased to between 5 and 40 times that obtainable at room temperature. Alternatively, for a given tool life it was possible to increase the metal removal rate by percentages ranging from 33 to 200.

Equally impressive results were obtained from milling tests, with increases in tool life of 4 to 100 times for the same cutting speed, or increases in metal removal rate of 2 to 4 times for the same tool life. For one of the work materials—a nickel base, high temperature alloy—it was necessary to raise the temperature to nearly 2,000 deg. F. before the desired increase in tool life was obtained. Hot end-milling and hot drilling have also been carried out successfully, but for the latter operation the temperature is more critical. In one instance it was found that there was a substantial increase in the life of the high speed steel drills when the work temperature was raised to 300 deg. F., but at higher temperatures the strength of the drill point was reduced more than that of the workpiece.

Although the heating of the work material for machining necessarily involves some added complication, there is now such a wide choice of methods that this drawback, it appears, need not be very serious for many applications. These methods include heating by furnace, electrical resistance, gas flame, infra-red radiation, induction, radio-frequency resistance, and electric arc. It is not

(Continued on page 1518)

Producing the C.A.V. Type DPA Diesel Fuel Distributor Pump

Selected Operations on the Cam Ring and Roller Shoe

By A. W. ASTROP, Associate Editor

In the heading illustration are shown the cam ring and roller shoe, with and without its associated roller, for the type DPA diesel fuel distributor pump, of which between 5,000 and 6,000 per week are being produced at the Rochester works of C.A.V., Ltd. Previous articles* in this series have included a description of the pump, also the principle of operation, and reference has been made to selected operations on rotors, barrels, barrel sleeves, and pumping plungers. These parts are incorporated in what is termed the "hydraulic head" of the pump, as are the cam ring, shoes and roller seen at the right.

It may be recalled that diesel fuel is pumped through the bore of the rotor by means of two opposed plungers housed in the head of the latter, and that these plungers are moved towards each other, to provide the pumping action, by lobes in the bore of the cam ring. The lobes can be clearly seen in the heading illustration. A cam ring with 4 lobes serves for the delivery of fuel to 2- and 4-cylinder engines, and a 6-lobe ring, to 3- and 6-cylinder units. Interposed between the outer end of each pumping plunger and the bore of the cam ring there is a special shoe, as seen at the bottom left, and this shoe incorporates a groove, of part-cylindrical section, in which a free-running roller is seated. The shoe embraces the roller for slightly more than 180 deg., and the latter is in direct contact with the bore of the cam ring.

As the rotor is driven, the roller successively encounters the lobes, with the result that the roller and shoe are thrust inwards. This motion is transmitted to the pumping plunger, and since the lobes in the cam ring are arranged diametrically opposite, similar and simultaneous motion is imparted to the other plunger. During the return stroke, the plungers are moved outwards by the pressure of the incoming fuel for the next cycle, assisted by centrifugal force. This arrangement is an important feature of the design of the pump, since it eliminates the need for return springs, which would be heavily stressed, and would have a high operating frequency.

* Machinery, 99/1060—8/11/61; 99/1180—22/11/61.

PRELIMINARY OPERATIONS ON CAM RINGS

The cam rings are made from high-speed steel, and blanks of the required width are cut from bar stock on sawing machines by S. Russell & Sons, Ltd., or Ohler (Drummond-Asquith, Ltd.). They are then transferred to the starting end of a link-line incorporating a Gyromatic vertical automatic, a Diskus face grinding machine, an American vertical broaching machine, a Sundstrand automatic lathe, a Steinel 4-head special-purpose drilling and tapping machine, and a Funditor marking machine.

A close-up view of the Swiss-built Tavannes Gyromatic vertical automatic (Stanley Howard, Ltd.) is shown in Fig. 1, and it is arranged for automatic loading and unloading. At the right can be seen the automatic loading equipment, which incorporates an endless loop of pivoted, channel-section, holders. A view from the rear of the machine is given in Fig. 2, where the loading arrangements can be seen at the left. The loop is indexed in an anti-clockwise direction, as viewed in Fig. 2, and the blanks are taken from a transporter

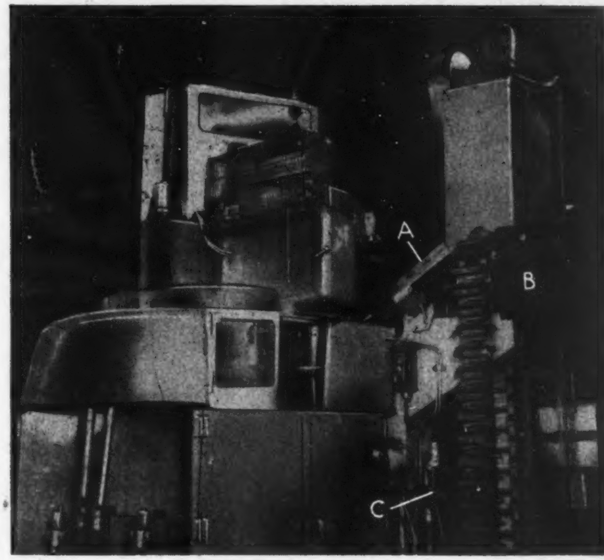
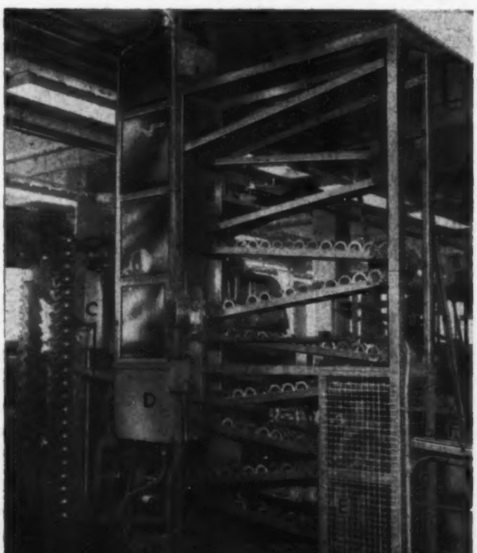


Fig. 1. Close-up view of the work-loading arrangements provided on a Tavannes Gyromatic vertical automatic. This machine performs preliminary operations on blanks for cam rings for the C.A.V. type DPA diesel fuel pump

bin and inserted in the holders. A number of blanks can be seen in position on the right-hand run of the loop.

The blanks are raised successively to the top of the loop, and when each is opposite the mouth of the chute *A*, Fig. 1, a pusher ram, housed within the guard *B*, is advanced. As a result, the blank is thrust from the holder and slides down the chute *A*. It is arrested at the bottom of the chute, and remains in this position until, at the required point in the machine cycle, an arm is actuated to raise it from the chute and insert it in the chuck. The Gyromatic machine provides for drilling and boring, in stages, a parallel, truly circular, hole in the blank, also for facing, and there are four working stations. One cam ring is ejected from the machine at the end of each cycle, and rolls down the chute *C*, Fig. 1.

This chute is similarly lettered in Fig. 2, and it leads to the bottom of a motorized, chain-operated lift, housed within the casing *D*. As each cam ring reaches the bottom of this lift it is picked up by fingers and is raised to the top of the casing *D*. Here, there is an automatically-operated plough mechanism which directs the ring into one of four parallel runways provided in the storage bank seen at the centre in Fig. 2. This bank is of the zig-zag type, and the rings are stored as seen in the figure. From the bottom track, batches of four rings at a time are raised by a shorter chain-type lift *E* to the chute *F*, whence they roll to the next machine in the line, which is a Diskus Werke (Rockwell Machine Tool Co., Ltd.) twin-head vertical spindle grinding machine.



FACE-GRINDING AND BROACHING OPERATIONS

A view of this section of the link-line, with the Diskus machine at the left, is given in Fig. 3, where the chute *F* is also indicated. The Diskus

Fig. 2. The chain-lift and storage bank provided between the Gyromatic machine and the Diskus face grinder, whereon the sides of the cam rings are ground

Fig. 3. First and second-stage grinding heads are provided on the Diskus machine, and the rings are passed through twice, once for each face

machine has a large-diameter rotary chuck, of the magnetic type, which serves to pass the rings successively beneath a first-stage and a finish-grinding head. The operator removes the rings from the mouth of the chute *F* and places them flat on the chuck, which is continuously revolving in a clockwise direction. They are carried first beneath the head *G*, and then beneath the head *H*, and are directed to another chain-lift and storage bank which is generally similar to that provided for the Gyromatic machine.

This equipment can be seen at the right in Fig. 3, and by means of the ball-ended lever *J* the rings can be diverted either to the subsidiary lift *K* or passed to the next machine in the line. The lift *K* raises rings from the bottom of the storage bank and feeds them into the 4-track curved chute *L*, whereby they are delivered to a point at the right-hand side of the operator. As they pass down the chutes *L*, the curves in the latter twist the rings through slightly less than 90 deg., to ensure that they leave the chutes with the unground side uppermost. The operator removes the rings from the chutes *L* and again places them on the chuck of the Diskus machine, and at the second pass the other side of each ring is ground.

Before starting second-pass grinding, the operator adjusts a steel plough which is arranged to overhang the right-hand side of the table and serves to sweep the rings from the latter as they leave the head *H* and to divert them into the de-magnetizer unit *M*. On leaving this unit, the rings are raised once more to the storage bank, but the lever *J* is now set so that the equipment will deliver them to the next machine in the line. It may be noted that the Diskus machine incorporates an automatic gauging unit, of the electric type, which checks the thickness of the rings as they leave the head *H*. Signals from this unit serve to lower the heads automatically, to compensate for wheel wear.

For broaching the cam form in the bore of the

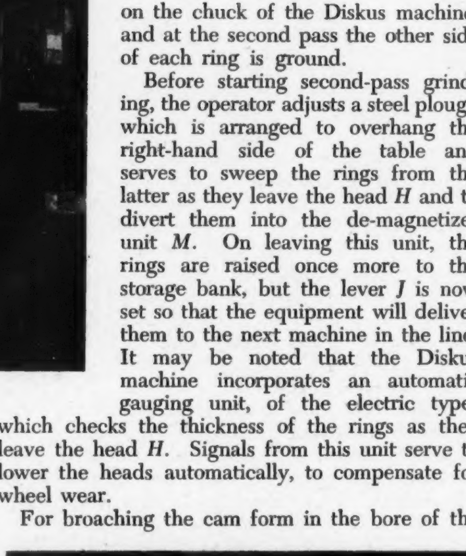


Fig. 4. The cam forms in two rings at a time are broached on this British-built American vertical machine

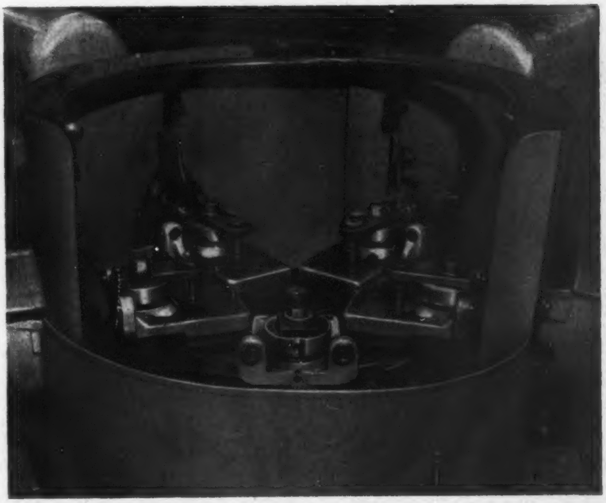


Fig. 5. Successive drilling, milling, chamfering and tapping operations are carried out on this Steinel special-purpose 4-head machine

ring a vertical machine is installed and is shown in Fig. 4. This machine was built in this country by Coventry Gauge & Tool Co., Ltd., under licence from the American Broach and Machine Co., U.S.A. (Rockwell Machine Tool Co., Ltd.), and incorporates a simple fixture in which two rings at a time are located by the peripheries, and the previously ground faces. The required form is obtained at a single pass, and the rings are then lifted from the fixture and are placed on edge, in the chute at the right, that delivers them to an adjacent Sunstrand automatic lathe. Here, they are turned on the periphery, also chamfered, and the machine is equipped for automatic loading and unloading. From this operation, the rings are passed to a Steinel special-purpose 4-head machine.

STEINEL MILLING, DRILLING AND TAPPING MACHINE

As explained in the first article in this series, provision is made in the DPA pump for advancing and retarding the point of injection by turning the cam ring relative to the delivery ports in the barrel. In effect, this action alters the angular relationship of the cam lobes, as a group, to the output ports. The slight turning movement is imparted to the ring automatically, by a small hydraulically-operated piston which responds to variations in the pressure of fuel oil delivered by the transfer pump. This piston acts against a ball-ended peg, which is screwed into the tapped hole seen at the 12 o'clock position in the cam ring in the heading illustration.

The flat is milled on the ring, and the hole is drilled and tapped, on a Steinel special-purpose 4-head machine (Catmur Machine Tool Corporation, Ltd.), and a close-up view of the working area is shown in Fig. 5. An indexing table is provided, on which five work-holding fixtures are mounted, and operations are carried out at four of the stations simultaneously, while cam rings are loaded and unloaded at the fifth. The ring is loaded on to a locator, which engages with the broached bore and ensures the required relationship between the cam lobes and the tapped hole. It is clamped in position by a swinging bar with an open-ended slot which engages with a screwed stud projecting from the fixture.

The table is indexed in the anti-clockwise direction, and at the first station (at the right in Fig. 5) a head advances to drill a tapping-size hole through the wall of the ring. At the next station, the flat is plunge-milled on the periphery of the ring, the cutter incorporating a pilot plug which enters the previously drilled hole. The head at station 3 is equipped with a special tool which is passed through the tapping-size hole and is then fed-radially, to chamfer the mouth in the bore of the ring, and station 4 provides for tapping the hole. It may be noted that each fixture incorporates a pair of hardened guide bushes. These bushes are utilized at station 1 only, the drilling head incorporating a pair of plungers which enter the bushes and ensure accurate alignment.

Subsequent operations on the cam rings include: marking various symbols and numbers on the Funditor machine; heat treatment; final face grinding on another Diskus machine; and peripheral grinding on a Precimax machine which is fitted with Stop-Cote sizing equipment and is arranged to handle two rings at a time, on a special mandrel which registers with the cam form. The rings are now ready for grinding the cam form in the bore, on a battery of special machines.

KEIGHLEY CAM-FORM GRINDING MACHINES

A close-up view of the working area of one of the special machines supplied by Keighley Grinders (Machine Tools), Ltd., is shown in Fig. 6. Before

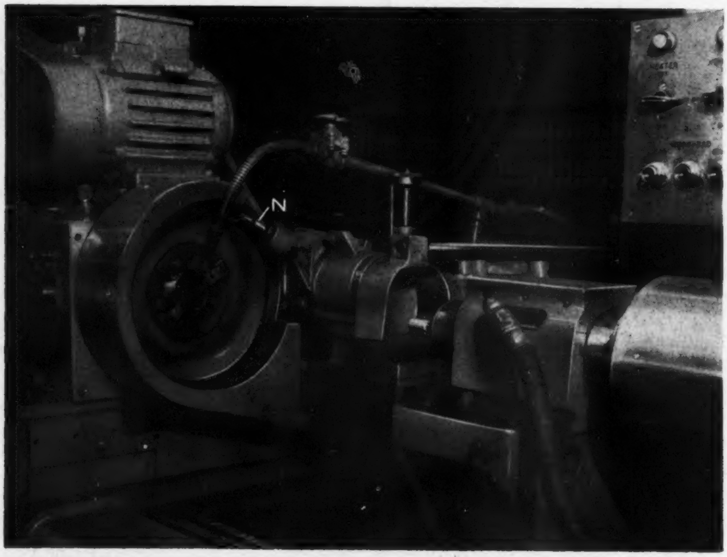


Fig. 6. One of a battery of special Keighley grinding machines installed for finishing the cam profiles in the bores of cam rings

the cam ring is loaded into the chuck, a special headed driving peg is inserted in the tapped hole in the periphery, and serves both for angular location and as a driver. The ring is located concentrically with the spindle by three arcuate-ended shoes, which are secured to the faceplate and engage the periphery, and in the axial direction it is positioned from one of the ground faces. There are two air-operated rocking-type clamps on the faceplate, which engage the outer ground face of the ring and hold it securely in position.

The spindle of the machine is carried on a heavy pivoted arm, and immediately behind the faceplate there is a large-diameter edge-type cam. The periphery of this cam is in contact with a roller that is rigidly mounted on the inside of the front wall of the headstock, and as the cam rotates in unison with the spindle the latter is swung backwards and forwards, through small angles. Under the control of the edge cam, the required form is produced in the bore of the ring, and it will be noted from the heading illustration that each lobe has two distinct crests.

Of the high-frequency type, the grinding spindle runs at 22,800 r.p.m., and a multi-pass cycle is employed, comprising the following stages: during the first pass the grinding wheel, while oscillating axially, is fed slowly through the work; on withdrawal, it is automatically dressed, by the unit *N*, and a second pass, similar to the first, is taken; after the wheel has again been dressed, a slow pass, without oscillation of the spindle is made; at the end of this pass, an electric timer is automatically energized and the wheel is allowed to remain in the work for a pre-set period, for sparking out. During each grinding pass, continuous transverse feed is applied to the work-head, which is finally brought up to a dead-stop on the base.

The surface finish on all ground portions of the ring must not exceed 10 micro-inches, and the faces must be parallel with each other to within 0·0008 in. total indicator reading. They must also be square to the periphery within the same tolerance. In addition, very close limits are specified for both shape and angular position of the cam lobes in the bore. For example, an inscribed circle that contacts the lobes must be concentric with the periphery within 0·002 in. total indicator reading.

INSPECTION EQUIPMENT FOR CAM RINGS

Cam rings are inspected on a 100 per cent basis, and a written record is taken of the results obtained from one ring every 35 min. With this arrangement, trends which may develop in connection with any stage of production can be detected readily, and remedial action can be taken. For the recorded check, particular attention is paid to the form of the lobes and their angular positions (or phasing as it is termed), also to concentricity and surface finish.

Inspection procedures are greatly facilitated by special equipment which was supplied by Optical Measuring Tools, Ltd., Maidenhead, to the requirements of C.A.V., Ltd., and a close-up view of this equipment is given in Fig. 7. A separate unit, which is visible on the right in this figure, is shown more clearly in Fig. 8. The O.M.T. equipment (Fig. 7) is employed for checking the form of each cam portion in turn, with the aid of a special graticule. A cam ring to be inspected is loaded, as at *P*, on a fixture which can be indexed

accurately to bring each lobe successively to the operating position.

A slide plate *R* is mounted on ball slideways for friction-free longitudinal and transverse movements. The left-to-right movement of this slide is imparted by the inspector, by means of the handwheel in the foreground, but in the transverse direction it is free to move under the control of a probe finger which is carried by the bracket *S*, and engages the bore of the cam ring. This bracket is bolted to the slide plate *R*, and the latter is spring-loaded away from the operator, so that the probe is maintained in contact with the bore of the cam ring.

In the far left-hand corner of the plate *R* there is a circular aperture, which serves as a seating for a glass graticule, and a number of these graticules is provided to suit the various cam forms in different designs of rings. On this graticule there is a fine line, which is accurately drawn to the required cam shape, full size. In the base of the equipment, and immediately below the graticule, there is a light source, which projects an image of the line upwards, on to a screen in the housing *T*. This screen is provided with twin lines, which represent the tolerance specified for the cam form.

When the slide plate *R* is moved from left-to-right, and vice versa, by the inspector, the graticule is moved likewise, and transverse movements are imparted simultaneously by the probe which is in contact with the bore of the ring. The projected image of the line on the graticule is observed by the inspector on the screen, and must not pass beyond the edges of the tolerance zone. In the left foreground in Fig. 7 can be seen part of a paper chart, which is wound round a drum, and it is on this chart that the inspection results are entered for one ring every 35 min. The ring is located in the fixture by an expanding mandrel, operated by the T-handle seen projecting at the lower end. This mandrel engages with a short portion of the bore, and the ring is positioned angularly by a peg which is inserted in the tapped hole and engages with a fork member provided on the fixture base.

The unit at the right in Fig. 7 (shown close-up in Fig. 8) is employed for checking the height of a selected portion of the cam form. As can be seen in Fig. 8, the ring is mounted on

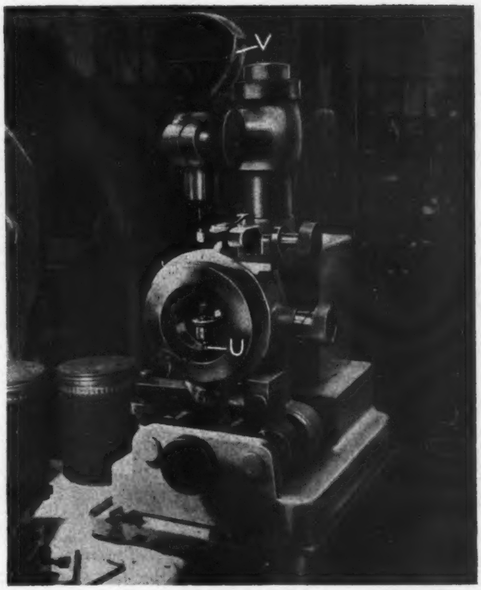


Fig. 8. Another special O.M.T. inspection unit

Fig. 7. Special optical inspection equipment supplied by O.M.T., Ltd., for checking cam profiles

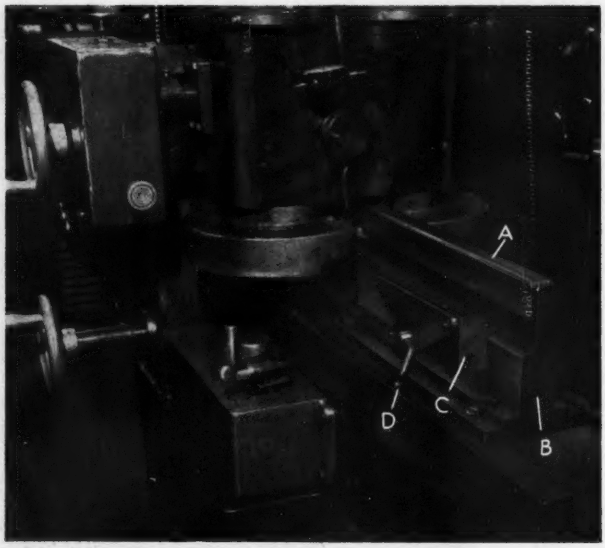


Fig. 9. Set-up on a duplex grinder for finishing the sides of roller shoes in batches of ten at a time

edge, and it is located by its periphery, angular positioning being provided by a peg, as on the equipment just described. Projecting into the bore of the ring there is a probe, as at *U*, which is driven by a small pulley and round-section belt. The probe is arranged eccentric to the pulley, so that it has a throw of approximately ⅜ in., and as it is driven it describes a circle which virtually embraces the span of the cam form.

Since it is maintained in constant contact with the cam profile, the probe rises and falls, and these movements are transmitted by a lever system to the Mercer gauge *V*. There are two adjustable pointers on this gauge, which can be set to indicate upper and lower limits, and the needle must not move beyond these limits if the ring is to be accepted at this stage. Provision is made for indexing the ring, so that each lobe can be inspected in turn, and the results of this check also are recorded at 35-min. intervals.

OPERATIONS ON ROLLER SHOES

A finished roller shoe is seen at the bottom left in the heading illustration, and the adjacent three-penny piece is included to give an indication of size. Blanks for the shoes are cut from bar stock on Russell saws, and early operations include de-burring on Roto-Finish machines, and grinding the top, bottom and side faces on Diskus machines. Further de-burring operations are then performed, followed by milling on a Centec machine which serves to produce the ear at each end. It may be recalled that the ears have an arcuate surface which is formed to a radius struck off-centre from the longitudinal centre line of the shoe, and in conjunction with slotted plates secured to the rotor, serve as stops, to limit the stroke of the pumping plungers.

Pollard drilling machines are employed to produce the part-circular seating for the roller, and after a series of de-burring operations, also hardening and tempering, the shoes are passed to a special duplex grinder, on which the sides are finish ground. A close-up view of the working area of this machine is shown in Fig. 9, where the two vertical-spindle grinding heads can be clearly seen. These heads are mounted on slides on a cross-rail, which is supported by a pair of columns, and the hydraulically-operated work-table passes between the columns, to carry the batch of workpieces between the wheels.

The heads are adjustable transversely on the rail, so that the distance between the wheels can be set, and each has its own driving motor, mounted vertically on the spindle housing. Shoes are ground on both sides in batches of 10 at a time, and a simple work-holding fixture is provided, as seen in position on the table. There is a steel blade *A* which forms a bridge, and is supported at each end by steel blocks, as at *B*. The lower edge of the blade *A* is formed to a radius which is slightly smaller than that of the roller seating in the shoe. Beneath the blade there is a heavy steel block *C* with 10 vertical bores arranged on a centre line which coincides with that of the blade *A*. In these bores there are 10 headed plungers, which can be raised and lowered as a group, through a small distance, by the lever *D*.

To load the fixture, the plungers are lowered and a shoe is placed on the head of each, with the roller seating uppermost and in line with the blade *A*. By turning the lever *D*, the plungers are raised and the shoes are thrust against the lower edge of the blade *A*, which aligns them accurately end-to-end. The plungers are raised by cam action, and there is a dwell portion whereby they are locked in the clamped position. Traverse motion of the table is then engaged, and the shoes are passed

between the wheels. The sides of the shoes are finish ground at this set-up, and the distance between them is brought to the required size within limits of +0, −0·0008 in. It may also be noted that on a finished shoe the roller seating, sides, top and bottom must be square and parallel with each other within a total indicator reading of 0·0009 in.

After bench inspection, the shoes are passed to a Keighley cylindrical grinding machine, on which the arcuate surfaces of the ears are ground, also the adjacent end faces of the roller seating. The machine is of the swivelling head type and a V-form wheel is employed, as can be seen in the close-up view in Fig. 10. Hydraulically-operated wheel dressing is employed, and there are two diamonds—one at *E* for the right-hand flank of the vee and one at *F* for the left-hand flank.

For the grinding operation, the shoes are loaded, five at a time, into a special fixture, and one of these fixtures is seen between the centres of the machine and another resting on the wheel-dressing slide in the foreground. Basically, the fixture comprises a 5-sided centre piece, with cone points at each end, and two thin steel discs, which are riveted together at the required spacing. These discs have apertures, through which the shoes can be loaded—from the side—and between the discs, and embracing the shoes, there is a simple "jubilee-clip" type strap clamp. When this clamp is tightened, by a screw, it contracts and thrusts each shoe radially inwards, so that the bottom surface makes contact with a flat on the centre pieces.

Fig. 11. General view of a special Mollart machine for grinding the roller seatings in shoes

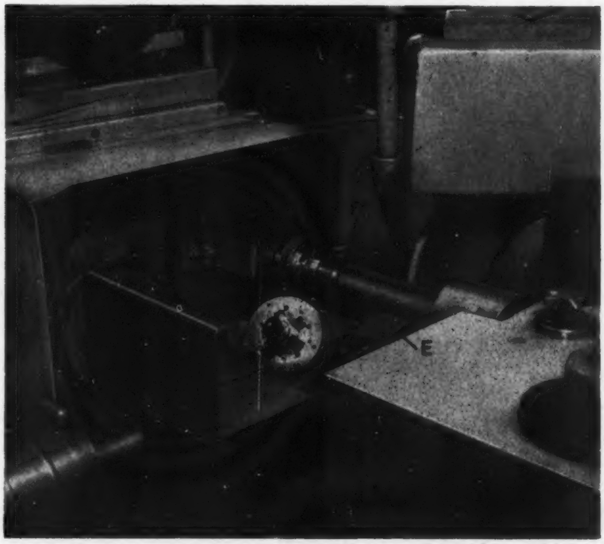


Fig. 10. The arcuate portions of the ears on roller shoes, also the end faces of the roller seatings, are ground on this Keighley machine with the aid of a fixture which holds five workpieces

The complete fixture is then loaded between the centres of the machine, and the automatic cycle is started. Plunge feed is applied to grind the arcuate surfaces of the ears projecting from the right-hand side of the fixture, followed by a small increment of longitudinal feed, to flash grind the end face of each seating portion. The wheel is automatically withdrawn, and the operator unloads the fixture, turns it end-for-end, and repeats the cycle to grind the ears and faces at the other ends of the shoes. During the automatic cycle, the operator is loading shoes into a duplicate fixture, and with this arrangement a high output is obtained.

At this operation, the step length of

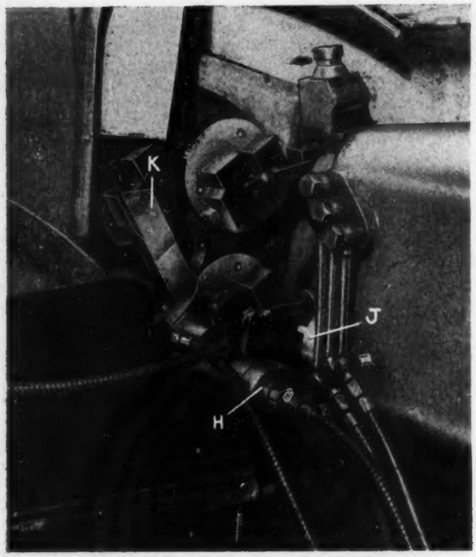


Fig. 12. Close-up view of the twin-spindle Mollart machine shown in Fig. 11

the ears is held to limits of −0, +0·006 in., and the length of the seating portion to +0, −0·002 in. The radius to which the arcuate portion of the ear is ground is held to +0, −0·004 in., and its maximum height from the bottom face of the shoe to +0, −0·002 in.

Further bench inspection follows, and the shoes are then passed to a battery of special-purpose Mollart grinding machines, on which the roller seatings are finished.

SPECIAL MOLLART SEATING GRINDERS

The tolerances for the roller seating, from the standpoints of size, geometry and surface finish, are stringent. For the diameter of the seating, limits of +0·0009, −0 are specified, and the finish must not exceed 15 micro-inches. Barrelling of the seating, however slight, is not permissible, and taper is limited to 0·00002 in. per side over the length. Bell-mouthing at each end can be tolerated, provided that it does not extend for more than 0·12 in. from each end, and does not exceed 0·00002 in. per side. It will be obvious that the grinding of the roller seatings to these limits presented a number of extremely difficult production problems, which were accentuated by the fact that the shoes are required in quantities of the order of 10,000 to 12,000 per week. Moreover, seat grinding is the last machining operation in the sequence, and it is obviously of great importance that the reject rate should be kept to a very low figure.

The method adopted provides for "generating" the seating, as a result of combined rotation of the work and oscillation of the grinding wheel, and the machines employed were designed and built by Mollart Engineering Co., Ltd., Surbiton, Surrey, in close co-operation with C.A.V., Ltd. A general view of one of the machines, of which four are installed, is shown in Fig. 11, and it is equipped for automatic loading and unloading. Shoes are loaded at random into the hopper *G*, which is of the electric vibratory type and incorporates means for correctly orientating the shoes for delivery to the machine. A complex panel at the rear, which may be seen immediately above the hopper, provides a visual indication, by means of pilot lights of different colours, of the complete operational sequence of the machine. Should a fault occur during the sequence, the operator need only refer to the panel to ascertain the stage which has been reached, and the most likely point at which the trouble has arisen.

A close-up view of the working zone, from the operator's position and with some guards raised, is shown in Fig. 12. The headstock has a drum which serves to carry four work-holding fixtures. Three of these fixtures can be clearly seen in the figure, but the fourth, at the bottom left, is partially obscured by the automatic work-loading mechanism. Shoes are delivered to the machine by the curved chute at the left, and are thrust into the fixture at the bottom left-hand position by the air cylinder *H*. The headstock spindle is then indexed in an anti-clockwise direction to bring the loaded fixture into line with the lower of a pair of high-speed grinding spindles, indicated at *J*.

This spindle performs first-stage grinding, and it is advanced into the bore of the shoe and is oscillated. At the same time, the work-holding fixture is slowly rotated, and when it has made one complete revolution the grinding head is automatically withdrawn. The headstock drum is then indexed through 90 deg. once more, and the fixture is brought into line with the upper grinding spindle. Oscillation of this spindle and rotation of the work fixture through one revolution follow for finish grinding the seating. A final indexing movement brings the fixture opposite the mouth of the chute *K*, into which the shoe is automatically ejected, for discharge into a container.

With this arrangement, a finished part is ejected at each indexing movement of the headstock drum. The twin wheels are automatically dressed

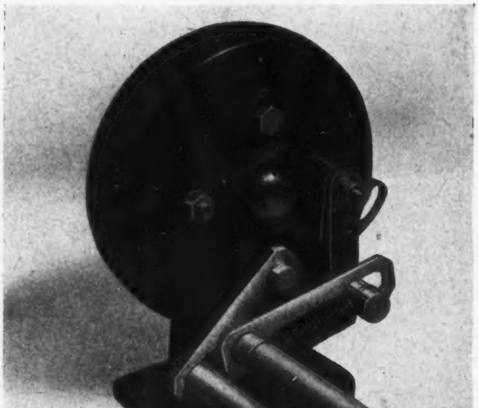
before each pass, and compensation is made for the consequent reduction in diameter.

In subsequent articles to be published in MACHINERY, attention will be drawn to other aspects of the practice of C.A.V., Ltd., Rochester, for producing DPA pumps, including the use of a Renault transfer machine for bodies, and the final assembly procedures.

Autoset Fixed-direction Wheel Unit

Incorporating a 6-in. diameter rubber-tyred wheel, the fixed-direction unit shown in the inverted position in the accompanying illustration is the smallest size of a range made by Autoset (Production), Ltd., 76-82 Stour Street, Birmingham, 18, covering assemblies with wheels up to 16 in. diameter, with tyres of different types.

The wheel spindle of this unit is mounted in bearing balls, which run in case-hardened tracks and are housed in the legs of the malleable iron flanged fork member. A 3¼-in. diameter internal expanding brake is provided, the twin shoes of which are faced with Ferodo friction material, and when two wheel units are mounted at opposite sides of a truck, their brakes are operated simultaneously by depressing the outer of two transverse bars, secured to arms which are pivotally mounted on the opposing inner fork legs. The brakes are then applied by tension spring, and can be released by returning the transverse bar to the upper position.



An Autoset fixed-direction wheel unit is here shown in the inverted position

Advance Type T.C.I.A. Electronic Counter

Shown below, the new type T.C.I.A. counter, for the measurement of time, period, and frequency, and the counting of regular or random impulses from zero to 10^6 per sec., has been introduced by

Advance type T.C.I.A. electronic counter

Advance Components, Ltd., Roebuck Road, Hainault, Ilford, Essex.

This counter embodies a thermally-compensated internal crystal oscillator which permits measurement to start immediately the instrument is switched on. The output is displayed on six in-line projection indicators for the numbers, and there is automatic indication of the decimal point and the caption. There is provision for an external standard, and self-checking facilities are incorporated for testing the operation of all circuits. This test is carried out by a 10-sec. count of a subdivision of the crystal frequency.

A sensitivity control permits discrimination against unwanted signals of lower amplitude than those being counted. Signals as low as 100 mV. r.m.s. and up to 250 V. r.m.s. at frequencies from 10 cycles per sec. to at least one megacycle may be measured. When adjusted for very low frequency input, the instrument can be used to measure frequencies below 10 cycles per sec. down virtually to d.c. Pulse width measurements can also be made, and output timing pulses can be varied in decade steps from 10^{-1} to 10^6. Provision is made for connecting an external recorder.

The instrument, which measures 16½ by 10½ by 10½ in., is designed for operation from an 85 to 140 volt or 190 to 250 volt. a.c. supply, with a frequency ranging from 40 to 100 cycles per sec.

The R.A.E. Efflux Drive System

By S. C. POULSEN, Associate Editor

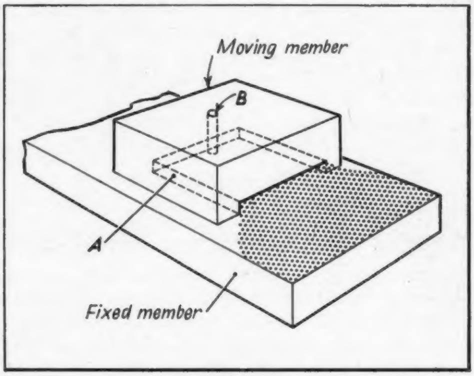


Fig. 1. Diagram illustrating the basic principle of the R.A.E. Efflux drive

As part of a study to devise improved methods of producing complex wind-tunnel models, and to meet unusual and stringent requirements in connection with a large numerically-controlled profile grinding machine, the Ministry of Aviation Royal Aircraft Establishment, Farnborough, has developed a novel high-performance hydraulic drive to the prototype stage. This drive (Patent Application No. 12534/60) is intended for continuous-control machine-tool duties, where the machining reaction forces are not high, and accuracy of positioning is important. Typical operations for which it is suitable include finish grinding, chemical milling, flame-cutting and inspection. It is also stated that it may have wider applications, for the accurate positioning of massive objects generally, including large astronomical telescopes. In addition to being suitable for linear motions, the drive can be designed for rotary motions.

The operating principle of the drive is shown diagrammatically in Fig. 1, in which a simplified uni-directional version is illustrated. A long shallow recess is machined in the under-side of the table or sliding member, as seen at *A*, and in conjunction with the flat surface of the stationary member, forms a pocket that is open at one end. A propulsive thrust is produced on the closed end of the pocket by forcing fluid into it through the channel *B*, and the fluid is either allowed to escape from the open end, as in the diagram, or may be scavenged away and returned to the hydraulic pump.

This thrust results from the pressure-difference along the length of the pocket, due to viscous drag on the walls, which also opposes it. If the total drag force is considered to be equally divided between the fixed and movable surfaces, the effective thrust is equal to $\frac{A}{2}(P_1\text{-}P_o)$ where *A* is the cross-sectional area of the pocket, and P_1 and P_o are the inlet and outlet pressures. The relationship between laminar flow and pressure-drop along the pocket can be calculated from the relationship:— Flow $= [1480\ b^3w\ (P_1\text{-}P_o)]/\nu\ L$ gal. per min., where *b*, *w* and *L* are the gap, width and length dimensions of the pocket, in inches, and ν is the kinematic viscosity of the oil, in Stokes.

A 2-way version of the device, with opposed pockets to balance the separating force tending to lift the moving member off the ways, is shown diagrammatically in Fig. 2. This arrangement forms the basis of the test rig shown in Fig. 3, in which the stationary member *C* comprises a square-section steel body with ground surfaces. The carriage *D* is supported on hydrostatic bearing-pads at each

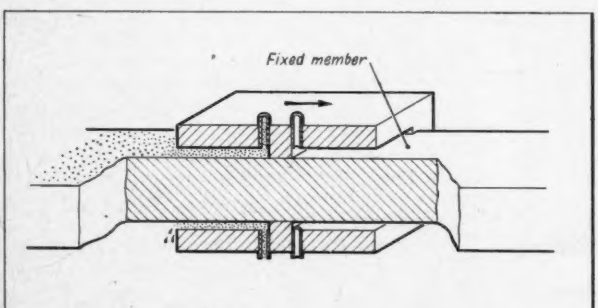


Fig. 2. Two-way opposed pocket arrangement, designed to balance the separating forces

end, which are arranged to oppose each other transversely and vertically, as at *E*. A total of four thrust pockets comprising two pairs arranged to provide thrust in opposite directions, is machined in the upper and lower inner faces of the carriage. These pockets are also opposed vertically, in order to balance the separation forces.

Since the photograph in Fig. 3 was taken, a large block of lead has been attached to the rig, at the far end, as viewed in the illustration, to simulate, more closely, the inertial effects of an actual machine-tool structure.

To enable the dynamic performance of the rig to be studied, it is arranged to operate in an electronically-controlled closed-loop servo system, with punched-tape numerical input, and moiré fringe position feedback. For controlling the rate of flow of oil to the pockets, use is made of a Dowty Moog valve * (*F*, Fig. 3). The rate of build-up of thrust is governed mainly by the performance of this valve, and by the capacity of the interconnecting ducts and manifolds. Principal particulars of the rig are as follows: pocket height, width and length, 0·006 in., 5·62 in. and 3·2 in., respectively; leakage gap, 0·001 in., nominal; side leakage path length, 0·5 in.; oil viscosity, 0·65 Stokes at 20 deg. C.; inlet pressure to valve, 1,000 lb. per sq. in.; differential pressure at pocket inlets, at 3 gal. per min. flow, 440 lb. per sq. in.; theoretical thrust at this pressure differential, 14·9 lb.; actual thrust, 14·25 lb.; moving mass of carriage, 200 lb.

* MACHINERY, 94/84—14/1/59.

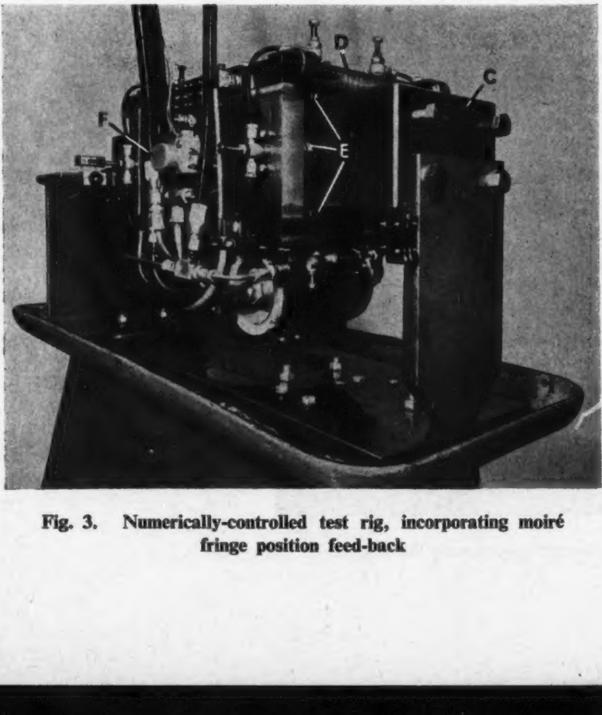


Fig. 3. Numerically-controlled test rig, incorporating moiré fringe position feed-back

Since there is no direct mechanical connection between the carriage and the ways, the stiffness of the driven element to externally-applied forces is entirely dependent on the action of the closed-loop positioning servo-mechanism. In the rig, a closed-loop gain factor of 5 × 10^4 in. per sec. per sec. output acceleration, per in. error signal, in conjunction with the carriage mass of 200 lb., gives a stiffness to external forces, of 26 lb. per 0·001 in. position error. Since the maintenance of this gain factor at other carriage weights results in a "scaling" of stiffness with carriage mass, a 2,000-lb. carriage, in the controlled state, could be expected to provide an incremental stiffness of 260 lb. per 0·001 in.

Advantages of the drive may be summarized as follows: (*a*) It is suitable for traversing and accurately positioning moving members, over almost any desired distance greater than 2 ft., below which it is not economical. (*b*) Since, when hydrostatic bearings are employed, there is no mechanical connection between the drive and the machine, it is free from inherent resonance, except possibly, for resonance in the fluid channels, when the system is used for very long traverses. (*c*) It affords rapid traversing speeds and rapid positioning, with a servo response of 30 to 50 c/s.

Although, as was indicated, the stiffness is high, it is pointed out that the maximum thrust obtainable is necessarily limited, and the drive is therefore unsuitable for applications in which heavy or intermittent loads are involved. Nevertheless, at R.A.E., attention is being devoted to the design of a higher-powered version, with a thrust of several hundred pounds. Meanwhile, studies of the dynamic performance of the test rig are continuing.

HELAZIPP TUBING FOR CABLE BINDING. The Plastics Division of Hellermann, Ltd., Gatwick Road, Crawley, Sussex, have introduced a flexible P.V.C. tape with beaded edges, which may be wrapped round a number of cables. This tape is then converted into an enclosing tube by zipping the beaded edges together. Interlocking is thus obtained and it is stated that the joint is dust- and moisture-proof. If it is required to trace or inspect the cables, the covering can be readily unzipped. In certain circumstances, the Helazipp tubing can be applied as a covering for conduit, to provide protection against corrosion.

Operations on Components for Littlejohn Missiles

By R. N. GREENBERG*

THE LITTLEJOHN ROCKET, which is designed to follow a ballistic trajectory, is being made under contract for the U.S. Ordnance Corps by the Consolidated Western Steel Division of United States Steel Corporation, Los Angeles, Calif., U.S.A. It is of solid-fuel propulsion type, and is unusual in that it is rotated on the launching rail prior to firing. The rotation, which continues while the rocket is in flight, ensures a high degree of accuracy, and the missile can be used effectively in support of troops in the field as a supplement to heavy artillery. Machined parts ready for assembly to form a rocket engine are seen in Fig. 1.

This rocket motor was designed and the prototype developed by engineers at the company's works in Los Angeles specially for the production of the shell or case by flow-turning. The shell, which is the principal component of the motor, is produced from a rough forging weighing approximately 250 lb. It is forged from a special steel developed by United States Steel Corporation for the purpose. Production batches of these forgings, after careful inspection, are sent to the 6-spindle vertical chucking machine illustrated in Fig. 2. Two separate series of operations on this machine are required to prepare the forging blanks for subsequent flow turning.

At the first set-up, one end of the blank is machined at each of the five working stations. After completing a batch, the machine is re-

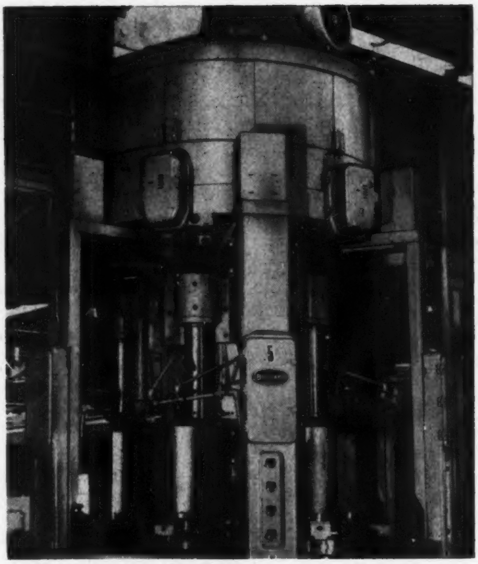


Fig. 2. On this 6-spindle vertical chucking automatic the motor-case forging blanks are machined in preparation for flow turning. The operations are carried out at two separate set-ups

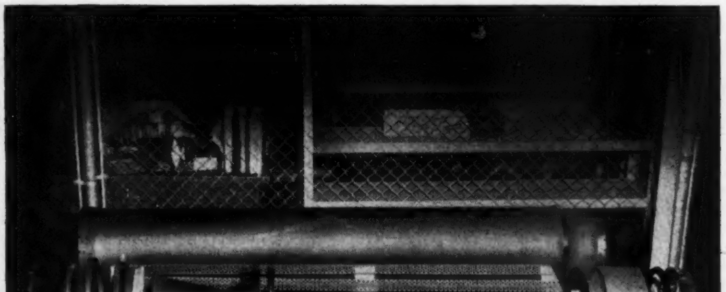


Fig. 1. Finish-machined components for a rocket engine ready for assembly

* Consolidated Western Steel Division, United States Steel Corporation, U.S.A.

Fig. 3. The third and final pass on the flow-turning machine is here seen in progress. Cold-working of the material avoids the need for subsequent heat-treatment

tooled for the second series of operations, which, again, is performed at five stations. All cutting tools used are of the tungsten-carbide throw-away tip type, and permit a high rate of metal removal from the blanks. Wall thickness of the cylindrical blank must be held to close tolerances in readiness for the next operation. Machining reduces the forging from the original 250 lb. weight to 90 lb.

The blanks are then transferred to the flow-turning machine shown in Fig. 3 on which rollers, applied under a force of 120,000 lb., form them against a polished hardened-steel mandrel. This forming operation reduces the wall thickness of the blank and increases its length. Hardened, precision-ground templates control the paths of the rollers, thus determining the extent of the reduction in thickness.

The flow turning technique has proved particularly suitable because the resulting increase in yield strength of the material due to cold-working is sufficient to avoid the need for heat-treating the missile case. Flow-turning is performed in three stages on the forged blank to reduce the wall thickness in equal increments from a nominal ½ in. to 0·100 in.

After the case has been flow turned, the length is approximately 2½ times that of the machined blank. The smooth finishes obtained on internal and external surfaces by flow-turning meet the high standards specified for the missile cases. For example, the interior surfaces have a finish of approximately 32 micro-inches.

Not only does flow-turning avoid the possibility of distortion which might result from heat-treatment, but it also eliminates the need for a longitudinal seam and the distortion associated with welding. The process also serves for material-quality inspection in that any flaws, laminations, or inclusions which may be present in the forging are immediately revealed. Such imperfections are readily detected by visual inspection after flow-turning, each rocket case being thus inspected prior to subsequent operations.

The parts are next transferred to the lathe shown in Fig. 4 on which special attachments are provided. On this machine, the missile case is automatically centralized and chucked, and the forward end is contour machined both externally and internally to a partial hemisphere, and the aft end is trimmed to the required length.

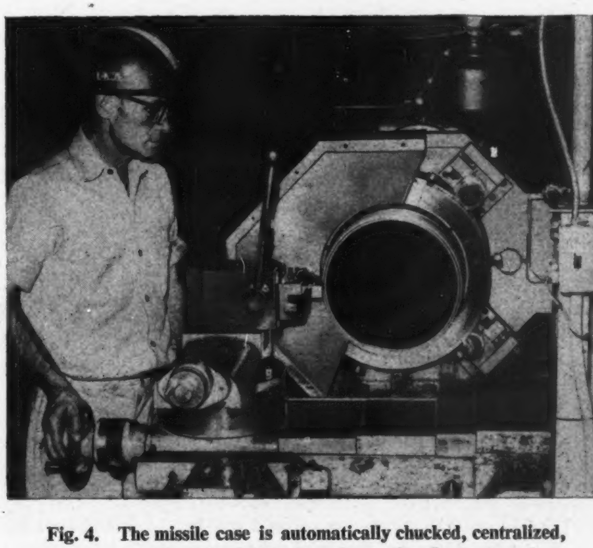


Fig. 4. The missile case is automatically chucked, centralized, cut to length and coutour-turned at the forward end on this specially-equipped lathe

From the automatic lathe, the motor cases are transferred to the special equipment shown in Fig. 5, which was designed and built by Consolidated Western Steel for welding the case to a formed steel head by the submerged-arc process. When this operation has been completed, a skirt ring, for fairing purposes, and a pedestal section, are welded to the case by the same process. Each weld is X-rayed 100 per cent to ensure maximum quality and reliability of the rocket case, and a permanent record is maintained of the X-rays for each case by a serial number. Although the surplus weld deposit associated with the submerged-arc process is held to a minimum, any excess deposit is removed by grinding prior to X-ray examination. This grinding also serves to ensure the balance and concentricity of the motor case which is necessary for the stability of the rocket in flight.

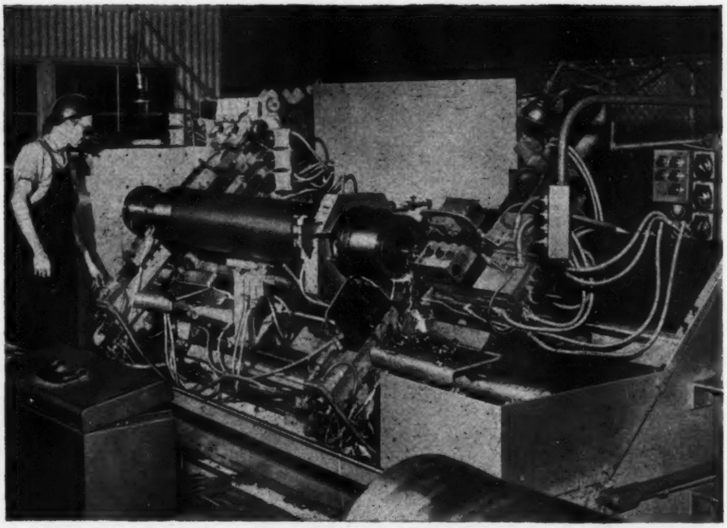


Fig. 6. Two series of operations are performed automatically on the missile cases on this lathe

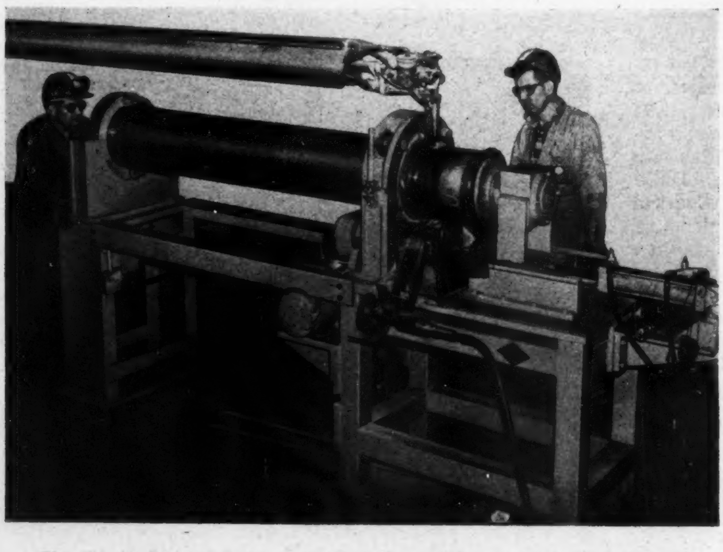


Fig. 5. At this set-up, the pedestal section and formed head are welded to the motor cases by the submerged-arc process. Each weld is subjected to a 100 per cent X-ray inspection

The missile cases are then transferred to the special automatic lathe illustrated in Fig. 6 on which they are machined in two series of operations, each sequence being controlled by limit switches and relays. For the first series of operations, the workpiece is gripped on an expanding mandrel, and the aft end is finish-machined to length, and turned accurately to a contour that will blend with the motor-case wall. Next, the pedestal section at the forward end of the case is bored, and external anti-friction bearing seats are semi-finish turned.

During the second

series of operations, the aft end of the case is first bored and a precision groove is machined for a retaining ring which subsequently serves to secure the finished nozzle in position. Subsequently, the two anti-friction bearing surfaces are finished machined, the pedestal section is faced to length, and a boss in the formed steel head is bored, turned, and faced.

After thorough inspection, the parts are passed to the special automatic drilling, tapping, and milling machine shown in Fig. 7. The motor case is one of the three principal components handled on this machine which is pneumatically and electrically controlled and is so designed that it can be changed over for operations on a different part in approximately 15 min. A total of 39 holes is drilled, countersunk and/or tapped in the motor case, in an automatic sequence. In addition, a small milling head machines a slot at the forward end.

Another important component of the Littlejohn rocket is the nozzle, which is machined from a rough closed-die forging of AISI 4130 steel weighing approximately 110 lb. There are five automatic operation stages, the sequences again being controlled by limit switches and relays.

Operations performed on the nozzle include machining the external and internal profiles, boring as seen in Fig. 8, grooving, and facing, all to close tolerances. The cycles time for the various stages are short, and smooth finishes are produced. After stringent inspection, the nozzle is transferred to the special drilling and tapping machine, on which 24 holes are machined in the flanged end. These holes serve for mounting another important component known as the nozzle extension.

This extension is also a closed-die forging, but is made from AISI 1018 steel. It is automatically machined in four operation stages which provide for rough-turning, rough-boring, grooving, profiling, finish-boring, and finish-turning, also facing and grooving each end. Subsequently, the nozzle extension is also drilled, tapped, and milled on the special machine shown in Fig. 7. At a single set-up, 34 holes are drilled and tapped in sequence, indexing taking place automatically after each stage.

A simple part which is nevertheless difficult to machine is the front shoe barrel whereby the forward shoe is mounted on the case to ensure accurate alignment and guidance of the rocket during launching. Turning and boring tolerances, and those on concentricity and ovality, are such as to permit insertion of precision anti-friction bearings.

Requiring neither strength nor durability, an aluminium captive locking ring is located at the forward end of the pedestal section to receive the rocket warhead. These locking rings are machined on conventional turret lathes.

The forward shoe, also, is not required to be durable, and is machined to close tolerances from an aluminium extrusion. This shoe, which is released from the rocket as it leaves the launching rail, has an intricate built-in mechanism to ensure release. Each forward shoe is rigidly checked by a functional test before assembly to the shoe barrel. Rocket components are painted while suspended from an overhead conveyor which carries them through a priming paint booth, a drying oven, a finished-coat paint booth, and a second drying oven.

After the nozzle has been mounted on the case, two anti-friction bearings are assembled at each

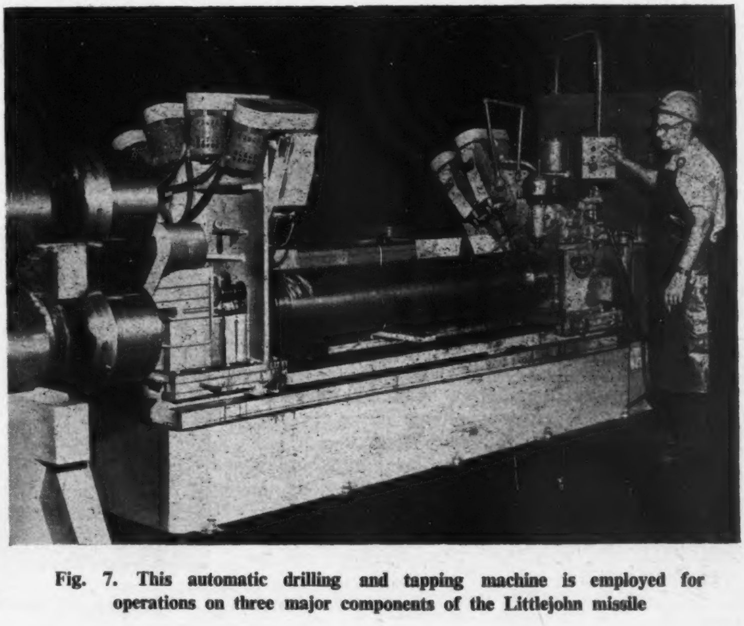


Fig. 7. This automatic drilling and tapping machine is employed for operations on three major components of the Littlejohn missile

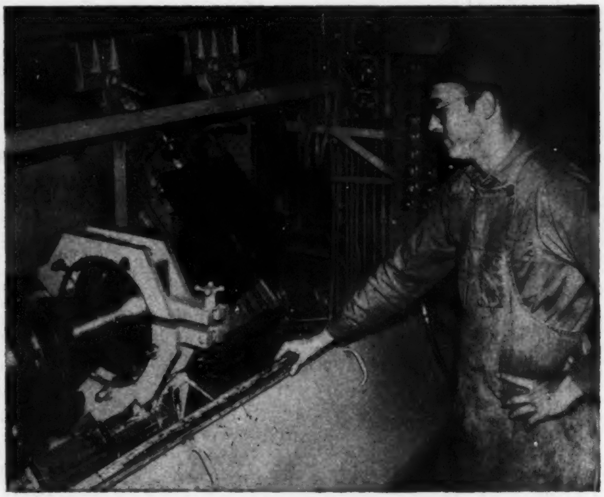


Fig. 8. Boring, which is here seen in progress, is one of five machining operations which are carried out on the forged nozzle under automatic control

end. The front shoe barrel is mounted on one set of bearings, and the other set provides for the aft shoe and barrel assembly.

A single unit is selected at random from a specified number of cases and transferred to a hydrostatic test chamber, where it is sealed and filled with water. Increasing pressure is then applied until the case bursts. This test provides a close quality control and reliability check of both the production process and the materials.

A bevel ring gear is provided at the junction of the aft end of the nozzle with the nozzle extension. This gear serves to rotate the missile on the launching rail. The assembly is also provided with a safety device (attached to the nozzle) which will neutralize the thrust in the event of unintentional firing. This thrust neutralizer must be removed before the missile is placed on the launching rail. Apart from careful inspection throughout the production and assembly stages, the exact centre of gravity of the completed rocket motor is determined in a special fixture.

The assembly is then transferred to a functional acceptance test fixture, which is operated by a qualified inspector and serves to determine the horse-power for rotating the rocket at a given speed to stimulate launching. Tests are carried out in this fixture under conditions corresponding to various inclination angles of the launching rail.

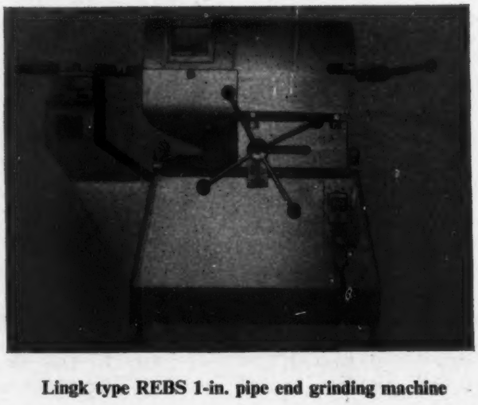
Additional components such as grain immobilizers and suppressors are also produced and assembled into the rocket, and each motor-case assembly is carefully weighed to an accuracy of 0·25 per cent. In accordance with inspection requirements, every dimension of the motor-case assembly is recorded and is retained.

Lingk Type REBS 1-in. Pipe End Grinding Machine

Shown in the accompanying figure is the Lingk type REBS 1-in. pipe end grinding machine which will handle pipes from $\frac{7}{16}$ to $6\frac{5}{16}$ in. diameter and grind a maximum length of 9¾ in. Grinding is carried out by means of two abrasive bands, one of which may be coarse, and the other fine, if required, to enable roughing and finishing to be carried out at the one operation. The bands readily follow the profile of the pipe, and rapid finishing is thus obtained with minimum metal removal.

Attachments available for the machine include a swivel vice for gripping exceptionally long or heavy pipes, and a device to permit grinding pipes which are severely corroded or badly scaled. In addition to the type REBS 1-in., machines can be supplied for grinding larger or smaller pipes.

The sole agents in this country for Lingk abrasive band grinders are Roland Goodall, Ltd., 19 Station Street, Burton-on-Trent.



Lingk type REBS 1-in. pipe end grinding machine

Thomas Ryder & Son, Ltd., Turner Bridge, Bolton

By P. A. SIDDERS, Chief Associate Editor

ESTABLISHED IN 1865, the firm of Thomas Ryder & Son was originally formed to manufacture textile rollers. The founders, Mr. Thomas Ryder and his son George, were both men of wide experience in the textile roller trade, since they had been employed by Thomas's elder brother William, who was also engaged in this field of manufacture. Thomas in particular was a good mechanic, and had been responsible for designing and building many special-purpose machines for roller production. He also originated the Ryder forging machine, which was awarded a bronze medal at the Great Exhibition of 1851. It may be of interest to note that this machine is mentioned in Karl Marx's "Das Kapital" to illustrate the vast increase in output obtainable by the use of machinery in comparison with hand methods of manufacture.

A single-storey factory was built on a site adjoining the house occupied by Mr. Thomas Ryder at Turner Bridge, Bolton. This factory measured 100 by 40 ft., and the original capital was £300. Initially, the company had a hard struggle to survive, since the roller making trade was extremely competitive. By the end of the year 1866, about 40 men were employed, and when Mr. Thomas Ryder died, the business was already securely established, and the special machines used, also the layout of the plant, form interesting examples of early mass production methods. The output at that time was about 6,000 bottom and 6,000 top rollers per week, and the manufacture of textile rollers still forms an important part of the company's activities.

For the next 19 years, when Mr. George Ryder was in sole control, the business prospered and expanded. On his death at an early age in 1893, the peak of development of the textile machinery industry had already passed, and his sons Tom and George, both of whom were minors, were faced with a very difficult situation when they succeeded their father. An obvious alternative line of business was the building of machine tools, since the

(Continued on page 1491)

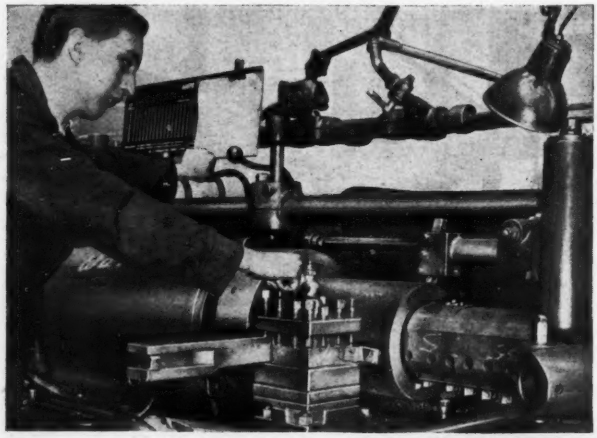


Fig. 1. A Ward No. 8 turret lathe set up for machining the eccentric sleeves that house the spindles on Ryder No. 8 Verticalautos. The centrifugal cast iron component is $10\frac{1}{2}$ in. long, and a series of $\frac{1}{8}$-in. steps is machined in the bore by six tools in the bar at the right, which is piloted in a bush in the machine spindle. Simultaneously, the exterior is turned with a knee tool, and a recess is machined by a tool at the rear of the cross slide. All tools are carbide tipped, and machining is performed at a speed of 84 r.p.m. and a feed rate of 68 cuts per in. Subsequently, the part is bored 3-deg. 6-min. taper, to 8·598 in. diameter at the large end

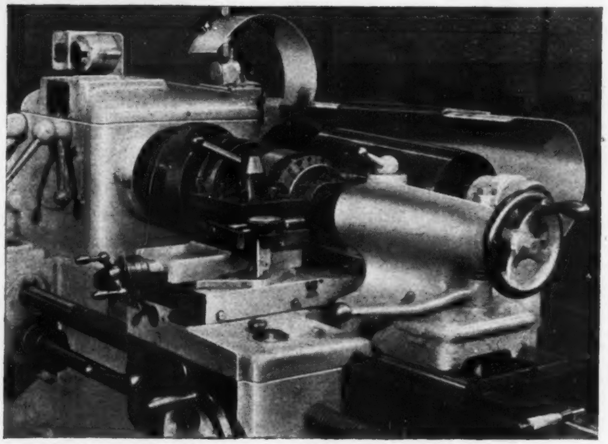


Fig. 2. Spindle housing sleeves for No. 6 Verticalautos are turned eccentric and taper on this adapted Edgwick lathe, after the spindle has been mounted in its bearings. With the spindle held stationary, the sleeve is driven in phase with a tapered and eccentric master at the rear of the machine. The cross-slide is urged to the rear by a weight, so that a bronze slipper is held in contact with the master. A dial gauge is fitted to the slide for checking the eccentricity (0·0075 in. on diameter). After the sleeve has been turned, a taper-bored outer bush is assembled, and the periphery of the bush is turned parallel

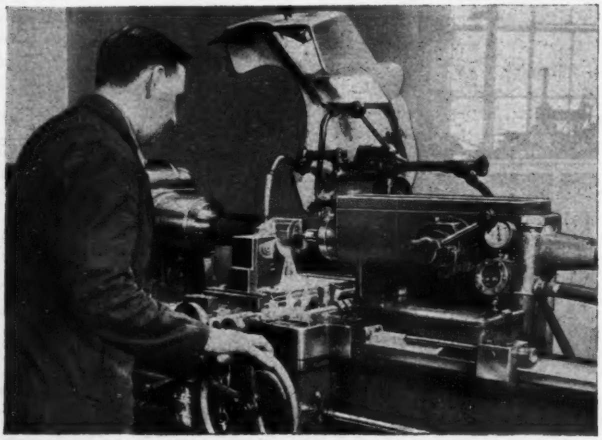


Fig. 3. Machining the work-spindle for a No. 6 Verticalauto on an H.E.B. OP 420 copying lathe, which is extensively used for shaft work. The forging, in En. 15 steel, is rough turned all over, leaving 0·010 to 0·012 in. of metal (on diameter) for removal during subsequent grinding. All shoulder lengths are maintained within 0·002 in., the tool being controlled by a circular master at the rear of the lathe. A Firth Brown TE+ tipped tool is used, and is fed at a rate of 0·014 in. per rev., the work being run at 250 r.p.m. The work is driven by pegs, in an adapter plate, which engage the chuck fixing holes in the flange

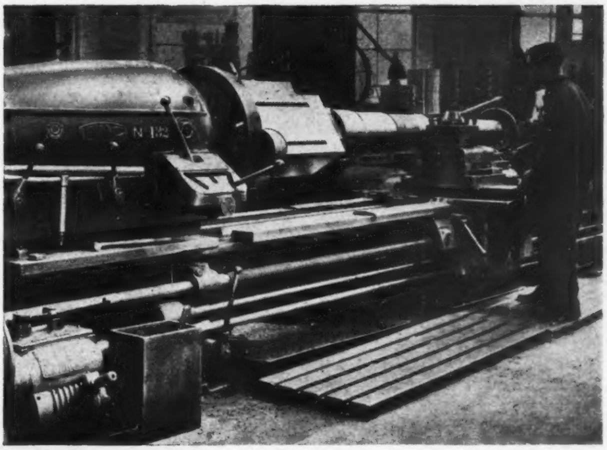


Fig. 4. Finish turning the column (which supports the slides and feed mechanism) for a No. 8 Verticalauto on a Lang lathe which will swing 36 in., and will admit 10 ft. 6 in. between centres. The component is first rough turned, leaving $\frac{1}{16}$ in. of metal all over, and the end is then planed to the shape shown, prior to the finish-turning stage, which is performed in two passes. For the first, the work is run at 67 r.p.m., and the feed rate is 48 cuts per in., the corresponding figures for the second pass being 102 r.p.m. and 96 cuts per in. A tolerance of 0·0005 in. is maintained on two 11-in. diameter portions of the column which receive bearings

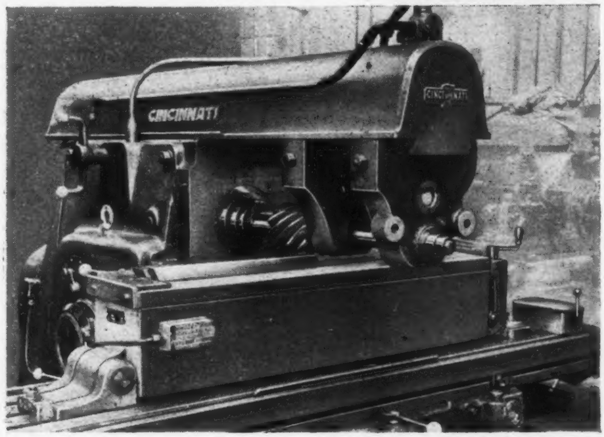


Fig. 5. Tapered adjusting gibs for use on No. 6, 8 and 10 Verticalautos are milled on a Cincinnati No. 4 horizontal machine with the aid of the Windley magnetic chuck shown. The chuck is pivotally mounted at one end and is provided with screw adjustment at the other. At the set-up shown, a mild steel gib strip, with 50-deg. angle faces, is being milled parallel, with a 5-in. diameter by 6-in. long helical slab-milling cutter. A feed rate of 4¼ in. per min. is employed, and the cutter is run at 78 r.p.m. When a batch of gibs has been milled, the chuck is re-set for machining the tapered side face

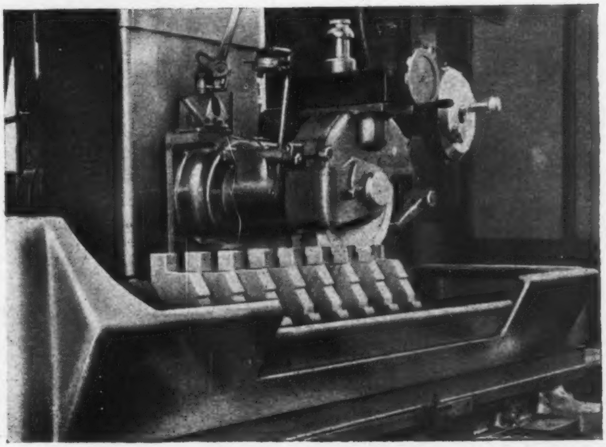


Fig. 6. Side faces of the tongues on the upwardly-projecting portions of eight feed couplers for use on No. 8 Verticalautos are ground simultaneously on this Jones-Shipman 10- by 27-in. surface-type machine. The base and long sides of the components are ground before this operation stage, and the tongues are held to 0·250 in., +0, —0·0005 in., a total of 0·015 in. of metal being removed from each tongue. Hitherto, the couplers were handled singly, but now that the operation is performed on batches, on a magnetic chuck, eight parts are ground in 60 min. The feed couplers are of weld-fabricated construction, with joints of very high quality

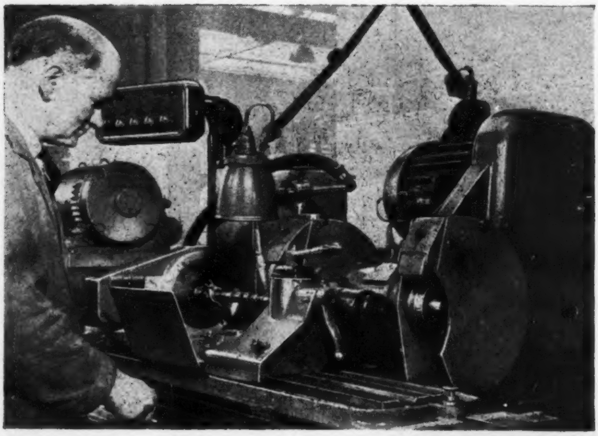


Fig. 7. This Jones-Shipman type 1300 EITU cylindrical machine is installed in the production grinding section of the Turner Bridge works. It has electronic control of the wheel-head spindle speed, which is steplessly variable from 0 to 200 r.p.m. The machine is fitted with a double-swivel backslide, and a wheel-head with twin wheels for external grinding, also a built-in internal grinding spindle. At the set-up shown, a precision roller is being finish ground. A second machine of the same type is to be installed in the grinding section in the near future

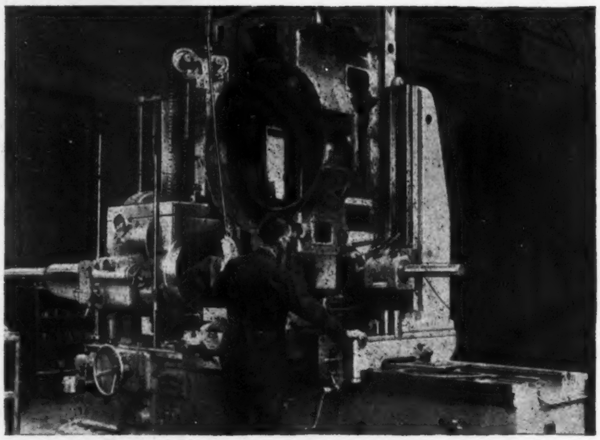


Fig. 8. One of several Kearns machines in the heavy machine shop, this type D3 patent borer is being used for operations on the main stator hole in the main base for a Ryder No. 6 Verticalauto. The position of the hole must be maintained within $\pm 0{\cdot}001$ in., and machining is performed with a pre-set tool-holder. Two tool bits are used for rough machining, and the hole is then finished to $12{\cdot}000$ in. diameter, $\pm 0{\cdot}001$ in., using one bit, at a speed of 56 r.p.m. and a feed rate of $0{\cdot}015$ in. per rev. A similar holder with two axial tool bits is used for machining the inner end of the bore, which is $15\frac{3}{4}$ in. deep

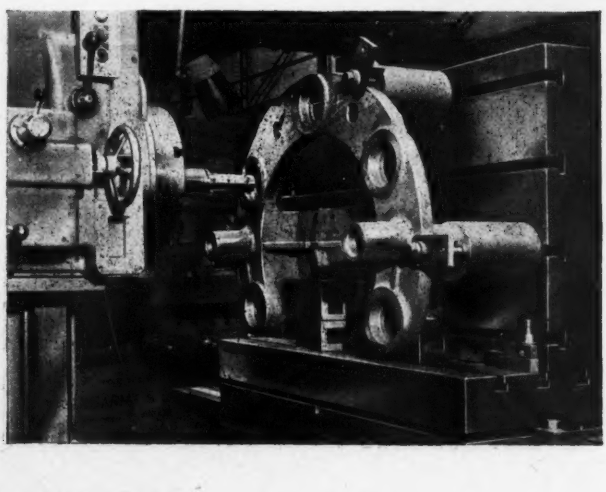


Fig. 9. At the set-up shown, on a Kearns Optimetric boring machine provided with quick-release tool-holding arrangements, five cored holes in a cast component for a Verticalauto are machined with a bar which has three pre-set tipped tool bits. Each hole is cored to $3\frac{3}{4}$ in. diameter, and is machined to a stepped form. The leading tool bit in the bar provides for rough machining right through, the second for machining to the smaller diameter of 4 in., and the third for boring the large end to $4{\cdot}250$ in. diameter, $+0$, $-0{\cdot}001$ in. The bar is run at 122 r.p.m., and is fed at a rate of $0{\cdot}010$ in. per rev. The radial and chordal positions of the holes must be held to $\pm 0{\cdot}0005$ in.

Fig. 10. This Webster & Bennett vertical turning and boring mill has an 80-in. diameter table and an external column and cross-slide. A special Timken roller race is incorporated to support the table. It is seen set up for operations on cast iron tables for Ryder No. 8 Verticalautos. The tops of the bosses and the flange are first rough machined, leaving ¼ in. of metal on the flange periphery. The component is then inverted, the flange is set true horizontally, the positions of the cored holes are checked, and the work setting is modified to suit the coring, if necessary, before further roughing and finishing operations are performed

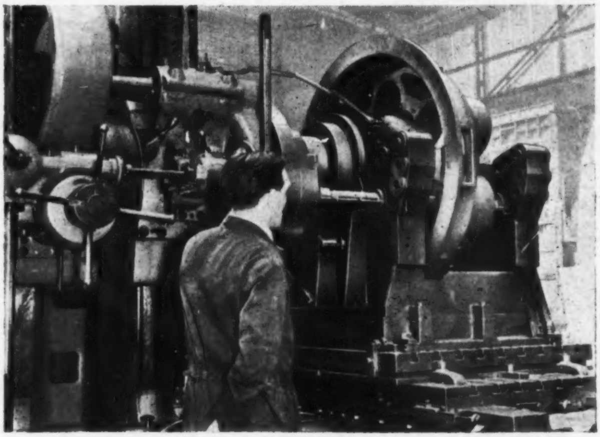
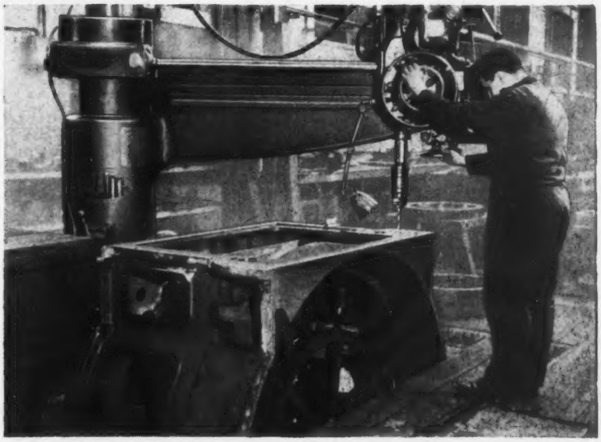


Fig. 11. From the Webster & Bennett machine, tables for No. 8 Verticalautos are transferred to this Kearns No. 1404 horizontal borer for machining the 10½-in. long, through holes for the spindles, using the jig shown. The work is mounted on a mandrel, and is first "clocked" true from a previously machined internal track, before the holes are checked to ensure the best setting relative to the coring. Once this setting has been established, the first hole is bored to 9·500 in. diameter, $\pm 0{\cdot}001$ in., using pre-set tooling. This hole is then used to re-locate the work by means of a plunger in the jig, for boring the second hole, and the procedure is repeated until all six holes have been machined

Fig. 12. After certain assembly operations have been performed and holes have been marked out, bases for No. 10 Verticalautos are drilled on this Asquith OD1 radial machine. The base is mounted on a spider, which has a central shaft with ball races at either end, and jack screws on the front ring of the spider are engaged with a machined annular face. This complete assembly is loaded into bearing seatings in the pit adjacent to the Asquith machine, and the various facings and pads to be drilled are set horizontal, in turn, by means of a spirit level. The back ring of the spider has tapped holes, on 4-in. centres, to receive a clamping screw in an angle bracket on the floor plate of the machine



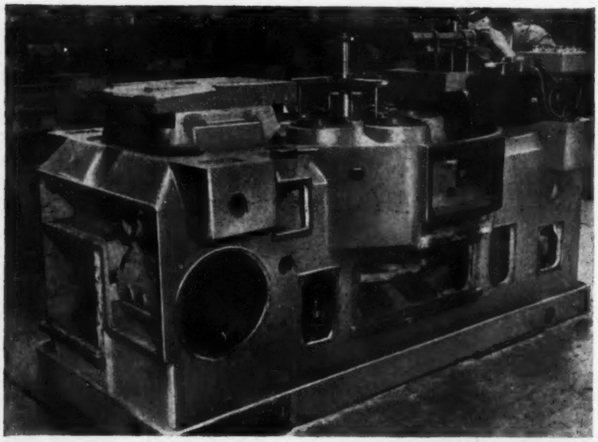


Fig. 13. During assembly of Ryder Verticalautos, an 8-in. Auto-Collimator is used to check the accuracy of the table indexing. The base of the machine is completely assembled at this stage, and the table is mounted on its own bearings on a dummy column, with a precision hexagon supported on a spider at its centre. Controlled from the temporary panel seen at the right, the table is indexed and positioned by each location insert in turn. At each position, the deviation of the corresponding face of the hexagon from the correct setting is determined with the Auto-Collimator, which is mounted on a facing slide

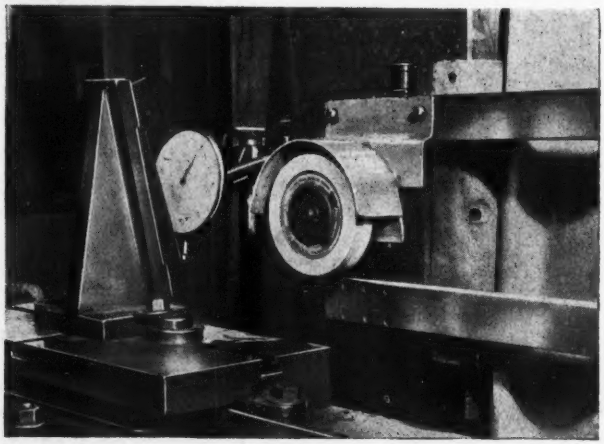


Fig. 14. From the readings obtained by the indexing check with the Auto-Collimator, corrections are calculated which are applied to the location inserts for the table of the Verticalauto. The inserts are dismantled, and each is corrected by grinding the locating face on a Brown & Sharpe No. 13 cutter grinding machine. As here shown, the insert is mounted in a fixture, with the location face horizontal, and the amount of metal removed during grinding is determined with the aid of a precision dial indicator gauge, calibrated in 0·0001-in. units. The machine has been modified by Thomas Ryder & Son, Ltd., and the wheel spindle is driven by a motor mounted on the head

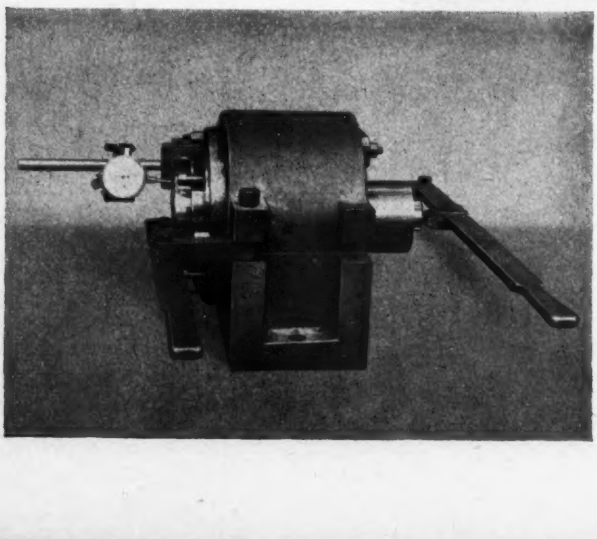


Fig. 15. This fixture is used for pre-loading the Timken bearings of Verticalauto spindle assemblies, with the spindle mounted in its bearings in the eccentric housing sleeve and outer bush, exactly as on the machine. The spindle is moved axially by means of the levers at either side of the fixture, the movement being indicated on the dial gauge. The spindle lock nut is then engaged by a pin, that passes through the fixture body, the sleeve and the bush, and the spindle is turned until all play has been taken up. A specific pre-load is then obtained by further rotation of the spindle to a setting indicated by a gauge which is graduated to correspond with the pitch of the spindle thread

firm had always made those required in the works, and had supplied a limited number to other companies. For example, machine No. 14, completed as early as 1866, was a simple type of lathe, and a 5-block forging machine was completed in the following year. The machine tool building side of the business was therefore expanded and a range of lathes, with cone pulley drive, was introduced.

A separate workshop for the building of machine tools was completed in 1900, and from that year the range of lathes was substantially extended, and some fairly heavy machines were built, considering the facilities available. By 1904, the company was building lathes with all-geared headstocks, and the design of the machines was at least abreast of the best current practice, and was influenced by Professor Nicolson and Mr.—later Professor—Dempster Smith of Manchester College of Technology. As was customary in that period, the range of machines built embraced many other types in addition to lathes, and it may be of interest to note that in 1901, a Ryder 36-in. hot sawing machine was constructed with an integral 3-cylinder steam engine—an early example of a machine tool with built-in power unit.

During the first world war, the machine tool department was heavily engaged in the building of lathes, but it was then decided that the company would produce more specialized machine tools after the cessation of hostilities. In 1923, the decision was taken to design and build a 6-spindle vertical automatic chucking lathe. A younger brother, Mr. Frank Ryder, who had joined the company in 1913, was temporarily relieved of other duties in order to design the new machine. No attempt was made to discover what had been done in this field elsewhere, and the final design was an entirely original conception. The prototype machine was shown at the Machine Tool Exhibition at Olympia, in 1924, and created considerable interest. Although by present standards the design was somewhat crude and had a number of major faults, the family resemblance to this original prototype is evident in the Ryder machines built to-day.

Sales of the early 6-in. machines were very limited, and a larger 8-in. machine was introduced at the 1928 Machine Tool Exhibition. Machines of this capacity found a much larger market, and the performance of machines sold to Ford Motor Co., Ltd., for their plants at Manchester and Cork, resulted in very substantial orders when the Ford plant at Dagenham was established. It was these sales which really represented the company's "break through" into the multi-spindle automatic field.

At the 1934 Machine Tool Exhibition, an entirely new No. 6 machine was shown, which had an electro-mechanically operated automatic cycle. This machine was somewhat in advance of its time, and although a number was sold before the second world war, it did not fully establish itself until 1947. During the war, Thomas Ryder & Son, Ltd., was mainly engaged in building two types of single-spindle automatic lathes, which were found to be very suitable for the manufacture of shells. The No. 8 vertical multi-spindle chucking automatic, similar to, but larger than the successful No. 6 type, was introduced at the 1948 Machine Tool Exhibition. In the early 1950's, it was decided to build an even larger machine, of very much heavier construction, in both 6- and 8-spindle forms. Subsequently, a 12-spindle machine was added to the range, and machines of this type weigh up to 30 tons when fully tooled.

The expansion programmes of the various motor car companies in 1959 found the company's production facilities inadequate for the orders received, in spite of extensive sub-contracting. Land on the other side of the River Tonge from the existing works was therefore rented on a long lease, and two high bays, of 20,000 sq. ft. total area, were erected, which provided an increase in the working space of nearly 80 per cent. At the same time, an extensive programme of machine tool purchasing was inaugurated. The transfer of plant to the new building permitted the re-planning of the existing machine shop and fitting department. At the same time, the decision was taken to separate the manufacture of tooling equipment from the construction of basic machines, since tooling had become increasingly more elaborate with the extended use of automatic work loading arrangements. Part of a department adjoining the demonstration bay was cleared to provide a tooling section, and the necessary machine tools were installed.

The heavy machine shop, which occupies one of the new bays, is equipped with one 10-ton and one 5-ton overhead travelling crane. Machine tools provided include a large Collet & Engelhard horizontal borer, and nine other horizontal borers by Kearns, among which may be mentioned a No. 4 wide-bed machine with a No. 5 spindle head. There is also a Webster & Bennett vertical turning and boring mill with an 80-in. diameter work-table. The introduction of this unit, which affords the optimum available combination of work-diameter and height capacity, has enabled many machining times to be halved.

In the medium machine shop, which is equipped with 3-ton overhead cranes, there is a group of capstan and turret lathes, including Ward 10/13 and Herbert 9B combination turret, and Herbert No. 4 machines. For milling work, there is a

number of Parkson, Cincinnati, and Kearney & Trecker-C.V.A. machines. A Lapointe type 3L horizontal broaching machine is installed, and, among other applications, is employed with an angularly adjustable fixture for cutting tools slots in boring bars. A Ryder lathe, which is 50 years old, is still used for certain specialized turning operations, and is stated to turn and bore to within 0·0005 in. for roundness. The grinding section is equipped principally with Precimax cylindrical and Jones-Shipman surface type machines. A Keighley angle-head machine is fitted with an internal grinding head built by the company.

The toolroom, which supplies and maintains tools and cutters for shop use, and makes cutting tools for customers' machines, has a well-equipped grinding section, with a number of Brown & Sharpe machines. A Newall type 2436 jig borer is installed, and the auxiliary equipment includes an O.M.T. optical rotary table.

Erection and fitting of the smaller Ryder machines is carried out in the second of the new bays, which is served by two 10-ton overhead cranes. Adjustable stands are provided to support the turning slides for No. 6 Verticalautos during scraping operations. No. 6 machines are built in batches of eight, and No. 8 machines in batches of ten, and the building period entails six weeks in the sub-assembly section and a similar period in the final assembly section. The fitting bay is heated by radiant emitters, supplied with high-pressure hot water from a boiler house at one side of the building.

Ryder No. 10 Verticalautos are built in batches of four in the heavy fitting bay of 12,000 sq. ft. area, remote from the new building. This bay has its own stores, and hydraulic and electrical sections. Adjoining it is the department for making tooling equipment, with its own machining section, the plant installed including turret lathes, milling machines (among which is a new Parkson 3V) and a Kearns Optimetric S-type horizontal borer.

There are now four descendants of the original founders of the company on the board of Thomas Ryder & Son, Ltd. The total number of people employed by the company is currently 545, as compared with 389 in 1959, and of this total, 75 are engaged in the production of rollers. There is a drawing office staff of 30, and the new drawing office, which was built in 1960, was further extended this year to increase its size by 50 per cent. The company has a total of 65 apprentices, who are trained for a 5-year period.

Typical set-ups and interesting items of equipment at the Turner Bridge works are shown in the accompanying illustrations.

Clifford & Snell Fleeting-contact Relay

Clifford & Snell (Engineering), Ltd., 32 Carshalton Road West, Sutton, Surrey, for whom the sole distributors are D. Robinson & Co., Ltd., 5-7 Church Road, Richmond, Surrey, have recently added to their range of plug-in relays a unit which has been developed from the type D.2600 and incorporates a small auxiliary relay. The latter can be connected in such a manner that it is operated for about 0·1 sec. either when the main relay is energized or released, or both.

The Clifford & Snell fleeting-contact plug-in relay is here shown with the re-designed base

Designated D.2600/F, the new unit is seen at the right in the accompanying illustration, and it can be mounted in any position. It is intended primarily for use in fault alarm systems, where a momentary contact is required to cause an audible signal to be sounded continuously until manually cancelled, but it may be incorporated in automatic control equipment, to provide for engaging a contactor or starting a process timer, for example. Since the contacts of the auxiliary relay may be normally-closed, as an alternative to the normally-open type, the unit can also be employed for releasing contactors.

On all relays in the D.2600 range, the contacts are now insulated by means of Mycalex. The socket base used in conjunction with each unit, which is shown at the left in the figure, has recently been re-designed, and is arranged for fixing by means of external screws. Identification numbers for the socket pins are moulded on the front and rear faces, to facilitate their use as test points.

A Linear Hydraulic Drive Employing Two Short-stroke Cylinders*

Some Design Problems

By R. BELL †

The drive here discussed was evolved by Dr. J. K. Royle (Manchester College of Science and Technology, and Massachusetts Institute of Technology) and was briefly described in a paper, of which he was co-author, with A. Cowley, presented at the First International Machine Tool Design and Research Conference, 1960. Although the merits of hydraulic cylinders as drive elements have long been appreciated by the machine tool industry, there is a definite restriction on the length of stroke that can be permitted, if a high drive stiffness is required. This factor is particularly relevant in connection with a controlled machine tool drive, where the drive forms the output member of a servo mechanism. For a given maximum output mass (table mass plus maximum workpiece mass) the drive stiffness is a major restriction on the servo mechanism band-width. Restrictions on the drive stroke can be eliminated if the single cylinder is replaced by a multi-cylinder drive, comprising a number of short-stroke (high stiffness) cylinders, suitably phased. Considerations of drive economics and control restrict the number of cylinders to the minimum, namely, two.

Such a drive has three distinct modes of operation, which are illustrated in Fig. 1, and the synchronization of the two short-stroke cylinders, to give coherent operation, presents a major design problem. As the two cylinders must be capable of either driving the table, or moving freely, it is necessary to provide a mechanism which affords a completely rigid link between cylinder and bed, and can be withdrawn. The method chosen is based on the use of hydraulically actuated pistons, to establish a friction lock between cylinder and bed. This paper is primarily concerned with these two problems.

For normal operation, there are several possible methods, based on input information, of maintaining control over the drive cylinders. Unfortunately, none of these methods can be universally applicable. For example, although it might be considered possible to programme the required change-overs on the input tape, such a procedure would involve, undesirably, the adaptation of any currently available equipment. The same can be said of the use of monitoring input velocity command, or the use of auxiliary counters to indicate the required change-over of control from one cylinder to the other.

A method has been proposed (J. K. Royle and B. D. Nellist, British Patent No. 857,030), involving the use of micro-switches only, for monitoring

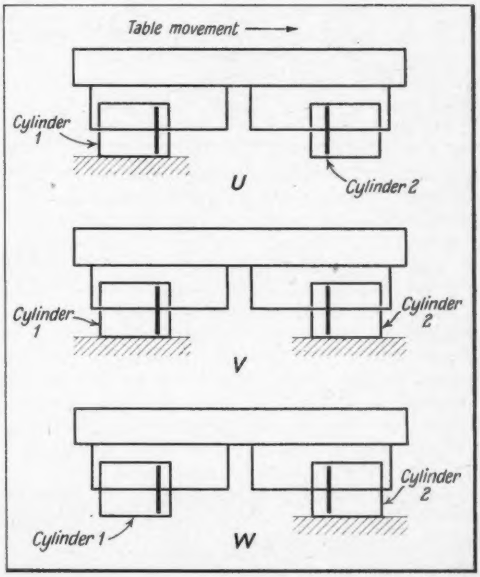


Fig. 1. Diagram showing the three modes of operation of the drive system. *U*—cylinder 1 driving, cylinder 2 free. *V*—change over, both cylinders driving. *W*—cylinder 1 free, cylinder 2 driving

* Abstract from a paper entitled "Design Problems Involved in the Development of a Linear Drive Employing Two Short Stroke Cylinders," presented at the Second International Machine Tool Design and Research Conference, Manchester College of Science and Technology.

† Manchester College of Science and Technology.

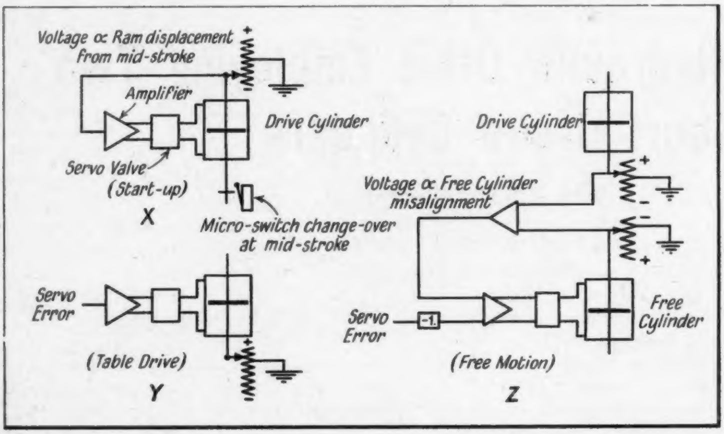


Fig. 2. Diagrammatic representation of the system for controlling the piston action

dicated by the actuation of the second of the three micro-switches attached to each cylinder, and coincidence of this condition for both cylinders causes the free cylinder to be locked. An indication of which cylinder is required to be unlocked is given by the third micro-switch.

An experimental unit, used to test the drive principle, comprises a table 2 ft. square, arranged to move on flat ways, with hydrostatic support. Each of the two cylinders has a stroke of 2·5 in., and each of the servo-valves provides a maximum rate of flow of 5 gal. per min., corresponding to a maximum velocity of 60 in. per min. A series of micro-switches is also provided, for monitoring the positions of the rams. This unit is intended to show the transient effects occasioned by change-over, and to indicate the result of applying hydraulic damping across the ram at the instant of change-over.

The friction lock between the drive cylinder and the machine structure should ensure that there is no slip between cylinder and structure, and it should not introduce any additional compliance to cutting forces. It has been demonstrated that locks can be designed to satisfy these requirements. For example, one experimental lock, incorporating eight pistons, affords a locking force of 4,500 lb. when pressurized to 1,500 lb. per sq. in. This force corresponds to a slip load of 1,600 lb., and for loads up to 90 per cent of this value, the displacement between the body of the lock, and the structure on which it is mounted, does not exceed 0·00001 in.

the movements of both pistons with respect to their cylinders. The method here presented differs only in detail, and three micro-switches are used on each cylinder. For starting-up, the two rams are caused to take up their mid-stroke positions, by using a voltage proportional to ram stroke control cylinder movement, with both cylinders free from the structure (*X*, Fig. 2). When the ram is at mid-stroke, a micro-switch is operated, and the coincidence of both rams at mid-stroke causes the drive to assume the operational state, with one cylinder locked to the structure, and the second at mid-stroke, but free from the structure.

DRIVE SYNCHRONIZATION

When a cylinder is driving, it is driven as shown at *Y*, Fig. 2, and when it is free, and is required to assume the correct position with respect to the drive cylinder, it is driven as indicated at *Z*, Fig. 2. To enable the free cylinder to assume the required position, the servo valve controlling it should be supplied with a signal of the opposite polarity, plus a signal which allows the free cylinder to assume a higher velocity than the driving cylinder. For this purpose, use is made of the potentiometers employed in the starting procedure, the outputs from the wipers being "differenced" and used to boost the speed of the free cylinder. This arrangement compensates for possible differences in the flow gains of the two ram systems. and for the fact that, in general, to keep in step, the free cylinder must travel faster than the drive cylinder. The approach of the end of stroke position is in-

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Birlec Continuous Furnace for Annealing Whiteheart Malleable Iron Castings

The gaseous process for annealing whiteheart malleable iron castings developed by A.E.I.-Birlec, Ltd., Tyburn Road, Erdington, Birmingham, 24, has been carried out during the past few years in continuous units as well as in the batch-type elevator furnaces originally employed when the process was introduced some 15 years ago. These continuous units are mainly applicable to foundries with outputs of at least 20 to 25 tons per week.

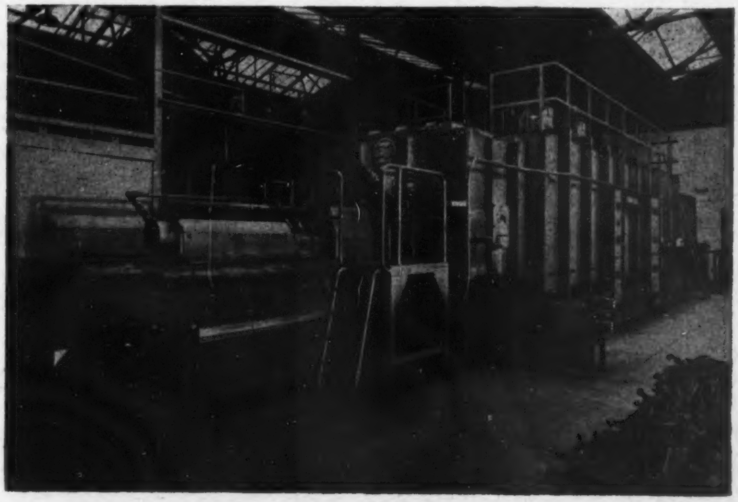
In the accompanying illustration is shown a continuous furnace with a nominal output capacity of 100 tons of castings per month which has been put into service by Bullers, Ltd., Tipton, Staffs. This company has operated three 300-kW. Birlec elevator furnaces for a number of years, but a considerable part of the output comprises castings which do not need to be spheroidized, and the continuous furnace is well suited to such work. It should be pointed out, however, that subsequent reheating of heavier castings, in preparation for spheroidizing cooling, could be carried out in the elevator furnaces or in a separate furnace associated directly with the continuous installation.

The furnace illustrated is electrically heated, although such furnaces can be designed for gas heating if required. It is of the pusher type, and the castings are loaded into specially-designed containers carried on cast nickel-chromium alloy grids. The latter, in turn, are supported on cast nickel-chromium alloy shoes, which rest on rails extending through the chamber.

Loaded work trays are brought to the furnace on wheeled trolleys, and at the inlet end there is a locked chamber with a hydraulically-operated elevator for bringing the trolley to hearth level. A hydraulic pusher, seen at the left in the figure, advances the work trays through the furnace. All the movements are hand controlled but a timing device warns the operator when the freshly-loaded work tray should be pushed into the furnace, with the consequent discharge of a finished tray from the opposite end.

From the heating section, the trays pass into a cooling chamber and then on to a wheeled trolley carried on a hydraulic elevator of similar design to that provided at the loading end, whereby the trolley is lowered to floor level. The atmosphere for the process is obtained by introducing into the chamber a controlled flow of humidified air produced with the aid of an electric water heater. Uniform decarburizing of the castings is ensured by the use of two air circulating fans in the heating chamber, and atmosphere composition is indicated continuously by a CO_2 recorder.

The furnace is rated at 250 kW., and the heating elements, which are located in the side walls of the chamber, are divided into three zones for control purposes. Elements of heavy nickel chromium tape are supported by replaceable pins, and adequate insulation is provided to ensure economic operation at the comparatively high temperature employed. Temperature control is



View from the loading end of the Birlec continuous furnace for annealing whiteheart malleable iron castings

maintained by indicating type instruments, and a 3-point recorder is also fitted.

At present the work is being treated on a 76-hour cycle, one tray being discharged every 4 hours. Each tray has a nominal capacity of about 11 cwt., the volume being 13 cu. ft.

Method of Testing a Large Lapping Machine Table for Flatness

By J. H. WILSON*

To enable large parts to be lapped to exceptionally close limits of flatness at the Pittsfield works of the Ordnance Department of General Electric Co., U.S.A., it became necessary to develop an improved method of checking the 84-in. diameter table of a Lapmaster machine. For this purpose, a checking bar was made from an 86-in. length of aluminium I-beam 3½ in. high, with 2¾-in. wide flanges and a 3/16-in. thick web. Three holes were drilled, counterbored, and tapped in the lower flange to receive hardened, spherical-ended feet. The feet have shoulders which abut the counterbored surfaces, and were ground individually to ensure that the bar was level when supported on a horizontal surface. There are two feet at one end of the bar, spaced 2 in. apart transversely, and a single foot located centrally at the opposite end. The distance from the single foot to the centre line of the other two is 84 in.

Holes were drilled and slotted in the vertical web of the beam to enable eight dial indicators to be secured in position by means of shoulder screws. Type C-21 indicators supplied by Federal Products Corporation, with dials reading to 0·0001 in., are employed, and clearance holes were provided in the lower flange of the beam, through which the indicator plungers project. The indicators are arranged in two groups of four, towards the ends of the beam, as seen in Fig. 1. Each of the extreme indicators is 3 in. from one end of the beam, and adjacent indicators in each group are spaced 10 in. apart.

The checking bar is set with reference to the surface of a 5-ft. by 8-ft. Herman granite surface plate. This plate was carefully inspected with the aid of an auto-collimator and it was found that on one diagonal the surface was straight within 50 micro-inches. With the checking bar resting on the plate and aligned with the selected diagonal, each indicator was adjusted bodily on the web until the plunger just touched the surface of the plate, and was then "preloaded" to the extent of half the total 0·01-in. travel of the needle. Finally, all the dials were adjusted in order to provide zero readings.

As a test for repeatability, the bar is lifted from the surface plate and replaced several times, and any necessary adjustments are made to the indicator settings. When lifting the bar, the end with the single foot is raised first and then the end with the double foot, to ensure that no tipping action occurs.

Before a check is carried out, the surface of the lapping table is thoroughly washed with solvent to remove any oil, also particles of metal and abrasive. The bar is then placed on the table, as shown in Fig. 2, the end with two supporting feet being set down first. Indicator readings are now taken to determine the degree of convexity or concavity of the table. Subsequently, the bar is lifted, turned about its mid-point and replaced, to enable readings on different table diameters to be obtained. Finally, the bar is replaced on

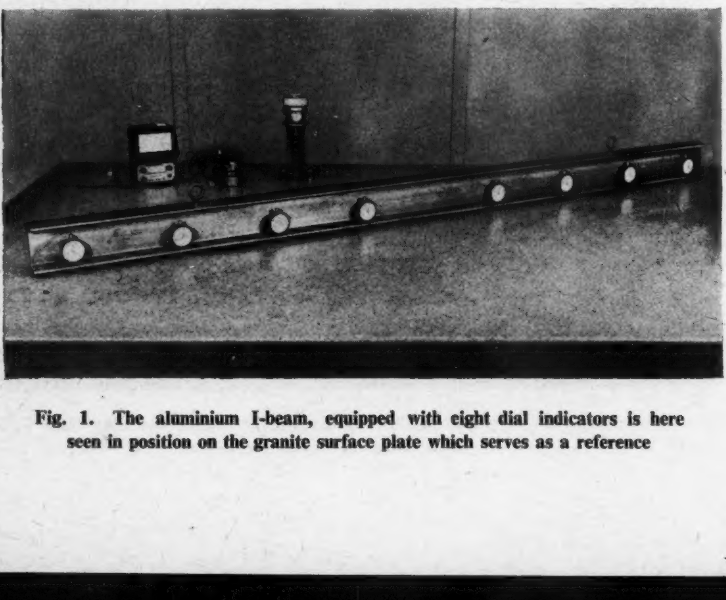


Fig. 1. The aluminium I-beam, equipped with eight dial indicators is here seen in position on the granite surface plate which serves as a reference

* General Electric Co., Pittsfield, Mass., U.S.A.

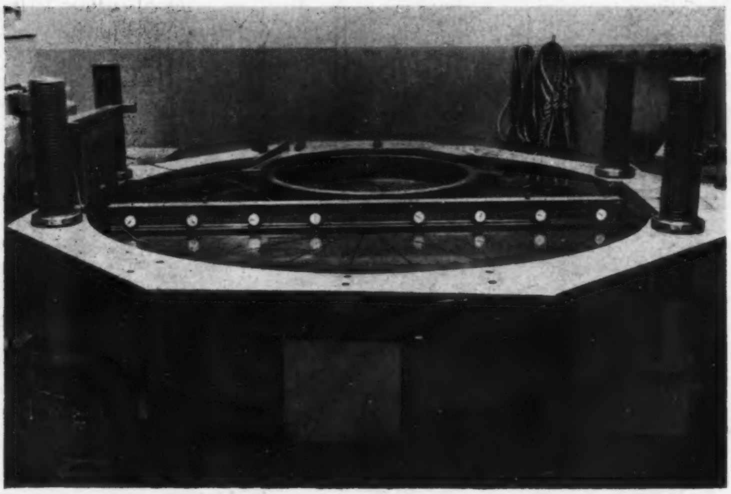


Fig. 2. With the checking bar applied to the table of the lapping machine, the extent of any convexity or concavity can be accurately determined

the surface plate and indicators are again checked.

If the table is found to be concave, the conditioning rings are moved outwards from the centre of the table, and if it is convex they are moved inwards. The table is then run and checked at intervals. Normally a ring adjustment of 0·25 in. is made. It has been found that if the table is allowed to wear convex or concave to the extent of 0·0005 in., it may sometimes be necessary to run it for 16 hours. For this reason, checks are made at fairly frequent intervals to ensure that errors of this magnitude do not develop. Experience has shown that provided the table is maintained flat to within 0·00015 in. on 84 in. the flatness of the surfaces on workpieces, regardless of their size, can be held to within $\pm 0{\cdot}000025$ in.

It will be understood that the checking bar here described serves purely as a comparator and that results obtained are not affected by any sag, which applies equally when the indicators are being set on the surface plate, and when the bar is in position on the lapping machine table.

Vacuum Tweezer Equipment

Vacuum equipment for use in the handling of miniature components is now being marketed by L. E. Simmonds Ltd., 5 Byron Road, Harrow, Middlesex, who are the sole concessionaires in this country for the makers, the Vacuum Tweezer Co., New Jersey, U.S.A. This equipment, which is shown in the figure, is designated Vacuum Tweezer System V-100 and is self-contained and portable. It is operated from a.c. mains supply and comprises a patented electromagnetic vacuum generator with adjustable pressure control, and a vacuum pencil with stainless pick-up tip. The pencil is connected to the generator by flexible tubing, and various shapes and sizes of pick-up tip are provided.

To hold a component, the operator merely touches the surface with the pick-up tip of the pencil, at the same time covering with the forefinger a small opening which is provided in the body of the pencil. As a result, suction is applied, to pick up the part, and when the opening is uncovered the component is immediately released.

Vacuum tweezer for handling miniature components

Dallow Lambert Dalamatic Dust Collector

EXHIBITS ON THE STAND of Dallow Lambert & Co., Ltd., Thurmaston, Leicester, at the recent Heating, Ventilating and Air Conditioning Exhibition at Olympia included one of the new Dalamatic automatic dust collectors. With the Dalamatic system, which is the subject of applications for British and foreign patents, cleaning of the vertically-mounted filter elements is effected periodically, and in a controlled sequence, by applying abrupt blasts of high-pressure compressed air, from nozzles mounted in the outlet passages. The resultant momentary reversal of the air flow, combined with the shock applied to the filter, serves to dislodge the dust which has been trapped on the opposite face. Design of the passages whereby contaminated air is conducted to the filters is such that the air flow patterns obtained assist downward movement of the dislodged material, which may be subsequently collected in an integral hopper or silo pressure vessel, or deposited on to a conveyor, for example. In this way, the pressure drop in the filtration system, caused by the dust trapped on the surfaces of the filter elements, is controlled without the need for interrupting operation of the equipment, and it is stated that the period during which compressed air is applied in the direction opposite to that of the main flow is of such limited duration that there is no significant reduction of throughput.

Fig. 1. An example from the Dallow Lambert range of Dalamatic dust collectors, in which dust is automatically dislodged from the filter elements, at regular intervals, by abrupt blasts of compressed air, without interruption of the normal operation

Fig. 2. In this close-up view may be seen the vertical pipes, whereby blasts of compressed air are distributed to the cleaning nozzles

The filtration system incorporates standard units, comprising one, two, or three tiers of nine individual filter elements, which may be arranged side-by-side or back-to-back, or in any desired combination, to form multiple assemblies capable of handling volumes up to 100,000 cu. ft. of air per min. Each element matrix is covered by a pad-type sleeve, which may be of various natural or synthetic materials, and the total fabric area per tier is 60 sq. ft. The design is such that the velocity of the air being filtered is high, and the continuously-rated capacity of a single-tier unit varies from 1,000 to 3,000 cu. ft. per min., according to the nature of the dust. Moreover, the elements serve to straighten the air stream, and thus aid in maintaining stable flow. It is claimed that the filtration efficiency is very high, and where the incoming air carries a proportion of heavy dust, a primary separator is incorporated, to ensure that only the finer material is removed by the elements.

A typical self-contained plant, with a 2-tier filter unit, is seen in Fig. 1. The contaminated air enters at the rear, near the top, and is drawn downwards, between the elements. After passing through the latter, it enters transverse outlet passages, and is then conducted upwards by a common vertical duct at the front, for discharge horizontally by way of the motor-driven fan mounted on the top of the plant. Dust is discharged through a rotary valve into a hopper at the bottom of the unit, and the compressed air, whereby it is dislodged, is supplied individually to the elements in the vertical banks through vertical pipes which are mounted slightly beyond the mouths of the outlet passages, as shown in Fig. 2. To enable a filter element to be withdrawn, the associated distribution pipe is first removed.

Compressed air is taken from a reservoir, the pressure in which can be varied by means of an adjustable valve, and is delivered to the distributor pipes through solenoid-operated valves. This equipment is housed, together with auxiliary items for the air system, in a dust-tight compartment directly below the filter unit. Arranged in a separate, lower, dust-tight compartment, the equipment whereby these valves are opened and closed in sequence includes a series of micro-switches, which are operated by means of cams on a shaft that is driven by a constant-speed motor, through reduction gearing. The frequency with which the operating cycle is repeated depends on the nature of the dust, but since it has been found that no improvement in performance is gained by extending beyond a certain maximum the time for which compressed air is applied to the filter elements, there is no provision for altering the duration of the period for which the valves are open. Removable covers are provided for these compartments, at the front of the plant, and there is also a hinged door, whereby access is gained to the clean side of the filter unit. The control equipment for the plant includes dials, on which are indicated the pressures of the compressed air in the supply line and in the delivery system for the cleaning nozzles, also the pressure drop through the filters, caused by dust on the surfaces of the elements.

Pitt Type L15 Ultra Low-loading Trailer

On the type L15, 10-ton capacity, ultra low-loading semi-trailer seen in the figure, which is built by Charles Pitt (Barton Stacey), Ltd., Barton Stacey, near Winchester, Hants., a single wheel-box at either side, in which the tandem wheels are carried by independent, pivoted, rubber-sprung trailing arms, is pivotally mounted at the front to the main chassis frame. For loading or unloading the vehicle, the boxes are disconnected from the chassis close to the rear end, where each is normally attached by means of two quick-acting mechanical locking units, and are then allowed to swing upwards, to permit the rear end of the chassis to drop to the ground, under the control of individual hydraulic cylinders. These cylinders are mounted in trunnions on a cross-beam at the rear end of the chassis, and the end of each piston rod is connected to the associated box. Finally, the hinged tail-board is lowered, to form a ramp, and with this arrangement, the gradient along which the load must be moved is slight, although the length of the tail-board is only 3 ft. 4 in.

A 2-ton capacity Thompson winch is mounted on the raised platform at the front of the trailer, to facilitate loading, and to raise the chassis to the travelling position, pressure fluid can be supplied to the hydraulic cylinders either by a pump to which drive is taken from a power take-off on the prime mover, when the operation is completed in 15 sec.,

Pitt type L15, drop-frame, ultra low-loading semi-trailer, which may be used for the transport of machine tools

or by a hand pump, a period of 1½ min. being then required. Locks incorporated in the cylinders are operated by a shut-off valve in the hydraulic system, and serve to supplement the mechanical units which are provided for securing the wheel-boxes to the chassis.

Although designed primarily for transporting fork lift trucks, the trailer can be employed for carrying various other types of equipment. In particular, it is suitable for delivery of machine tools to works at which no adequate lifting equipment is available. It has overall dimensions of 26 ft. 1 in. long by 7 ft. 6 in. wide, and on the 18-ft. 4-in. long load platform, the distance between the wheel-boxes is 5 ft. 3 in. If required, a body can be provided, to protect the load, and the company intend to market a range of semi- and full trailers of this design, with different capacities.

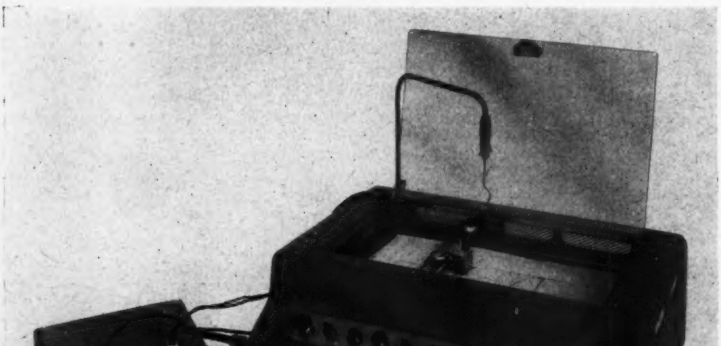
Bryans Plotting Equipment

The plotting table made by Bryans Aeroquipment, Ltd., Willow Lane, Mitcham, Surrey, takes graph paper up to 17 by 11 in., and has a plotting area of 15 by 10 in. It is an analogue table and high performance servo systems drive the pen to a position proportional to the signal voltages applied to the X and Y input sockets. The paper is held down by vacuum through a porous platen. It is claimed that repeatability is within 0·1 per cent of full scale movement, and a maximum pen speed of 20 in. per second is attained.

Three controls for each axis are provided. One control enables the datum position of the pen to be set anywhere along the axis, and there is a coarse and a fine control for sensitivity which can be set to any value between 0·07 and 7 volts per in. To enable curves to be plotted against time, a ramp function generator is incorporated, which may be set by means of a 6-position switch and the X axis fine sensitivity control to give sweep rate of the pen along the X axis of 0·1 to 10 in. per sec. The unit weighs 79 lb. and occupies a space of 24 by 19½ in.

The range of auxiliary equipment available includes a point plotter. This compact key-band has sets of keys for X and Y co-ordinates, each set comprising four decades and a + or − key. The co-ordinates of a point are set up by pressing the appropriate keys. Depression of the "print" key will then put a point on the paper at the corresponding position. If a symbol printer is used, various sets of points may be identified by printing them with different symbols.

A new piece of auxiliary equipment for use with the plotting table is a curve follower, which is shown in use in the accompanying illustration. The curve follower enables the table to be used as a "function generator". A curve that is to be followed is drawn in conducting ink or by fixing a wire to a sheet. A current is then passed through the wire and a special sensing head is attached in place of the pen. If a signal is now applied to the X axis, the pen will follow the conducting curve and an output voltage is available proportional to the Y co-ordinate of the curve corresponding to the value of the applied X signal. It is stated that a straight line may be followed to within 0·01 in., but the overall accuracy depends on the nature of the curve.



The Bryans curve follower unit, here shown in use, enables the company's co-ordinate plotting table to be used as a "function generator"

Analysis of Metal Flow in Die Casting Dies*

By Dr. ALBERT I. VEINIK

DIE CASTING is one of the most progressive and technically advanced of the foundry processes, and a study of the manner in which castings are formed within the die, when the metal is injected under pressure, is therefore of the greatest practical importance. Research into this matter, however, involves considerable difficulties arising out of the extreme physical complexity of the process. Experimental study is particularly difficult since one is concerned with processes lasting only a few milliseconds. For this reason, knowledge of the process is derived principally from empiric observations carried out during production, the results available from both theoretical and experimental research being far from adequate. In consequence, clear and precise principles which can be applied in the construction and operation of die-casting dies, or even die-casting machines, have not yet been established.

It is generally accepted, at present, that the factors most directly influencing casting quality include the intensity of thrust applied to the plunger, the velocity of injection, and the direction of metal flow. Complete analysis shows, indeed, that the most important single factor influencing metal injection is thermal balance.

Consideration of every other relevant factor—the hydrodynamics of the inflowing metal stream, the details of die layout, and machine construction—must yield precedence to a consideration of those temperature conditions that promote the production of sound castings.

A brief analysis of the process whereby the cavity fills with molten metal may now be given. The complete solution to the problems involved is lengthy and cannot be examined here. Nevertheless, some preliminary observations relating to the problem as a whole will provide a basis for further discussion. The cooling of the metal as it flows is characterized by several special features, with which the writer has already dealt elsewhere, and simple formulæ predicting the flow of metal in non-metallic dies, or dies faced with an insulating dressing were there derived. Experiment has shown that during the very short time period required for the filling of a die-casting die cavity, there is little difference between the temperature of the injected metal and the temperature of the die surface, the latter being raised to the temperature of the metal stream. The conditions are thus parallel to those observed when metal cools in a non-metallic mould, and we can accordingly make use of the relations which we have already established for the latter condition.

On this basis, therefore, the injection temperature is determined by the following equation, which provides for frictional effects:

$$t_1 = t'_1\,init. - \frac{b_2(t'_1\,init. - t_\phi)}{\sqrt{\pi}\,.\,R_s\gamma'_1 S'_1}\,.\,\frac{Z - z}{\sqrt{(wz)}}\ \text{deg. C.} \qquad \ldots\ldots\ldots(1)$$

where

t'_1 = temperature of the section of the metal stream examined, in deg. C.

$t'_1 init. = t_1 init. + \Delta t$ = the temperature of the gate section of the metal, in deg. C.

Recent advances in pressure die casting, especially the introduction of vacuum methods and the tendency in the motor vehicle industry to demand larger and thinner die castings every year, have emphasized the critical influence of metal flow in the cavity upon the quality of the casting. In the U.S.A., the Die Casting Research Foundation has embarked upon a project for the study and collation of all published papers on metal flow. Nowhere has more fundamental work on metal hydrodynamics been carried out than in the U.S.S.R., and Dr. Veinik is known particularly for his investigations of the thermodynamics of the die/metal interface and the influence of mould dressings in gravity die casting. Although not all workers in the field would dismiss so summarily factors other than thermal ones, his insistence on the importance of the latter is certainly valid and the simplicity of his treatment classical. The translation is by Romain Grunberg and Jehane Barton

* This paper was presented at a conference on pressure die casting arranged by VNITOL (The Russian Association of Foundry Technicians).

$t_1init.$ = the temperature of the charge of metal in the shot sleeve, in deg. C.
Δt = increase in temperature due to friction in the gate, deg. C.
b_2 = thermal coefficient of the die material in kcal./kg./hour/deg. C.
t_ϕ = initial temperature of die, in deg. C.
$R_s = F_s/S_s$ = calculated characteristic width of metal stream, in metres.
S_s = perimeter of the transverse section of the metal stream in contact with the die and subject to heat loss, in metres.
F_s = transverse section of the metal stream, in m.^{2}
γ'_1 = density of the molten die-casting alloy in kg./m.^{3}
S'_1 = specific heat of the alloy in kcal./kg./deg. C.
w = the rate of metal flow across the given section, in m./hour.
z = the distance in front of the stream to the section examined, in metres.
$Z = wT$ = the distance travelled by the metal in time T, in metres.

In calculating the variations in the temperature of the metal stream for different values of z and Z, all the values required for equation (1) except the velocity of flow w are known or can be determined by measurement.

The thermal phenomena attendant upon the filling of the cavity should be examined in conjunction with the metal flow, which is determined by, and depends upon, the action of the injection plunger upon the molten metal. We must therefore concern ourselves primarily with determining the velocity of flow w, using the balance-of-forces equation which, in the general case, has the form

$$P_{np} = P_{fr} + P'_{fr} + P_{in} + P_a + P_{hy} \quad \text{......(2)}$$

where

P_{np} = the nominal injection pressure, calculated by finding the product of the surface area of the plunger end and the pressure of the hydraulic medium in kg.
P_{fr} = the frictional force of molten alloy against the die, in kg.
P'_{fr} = the frictional force between the plunger and shot-sleeve, etc., in kg.
P_{in} = inertia energy.
P_a = back-pressure of the air remaining in the cavity, in kg.
P_{hy} = friction within the hydraulic system, in kg.

To simplify the problem, let us consider only the chief factors—the influence of the friction of the injected metal against the die surface, and the inertia of the metal. We can safely neglect the friction within the hydraulic system P_{hy}, because the hydrodynamic resistances within the die are far greater than those of the machine oil-hydraulic system, so that P_{fr} is very much greater than P_{hy}. Under these conditions, the nominal injection pressure P_{np} may be considered as being actually applied by the plunger to the metal.

We may also neglect P'_{fr}, or alternatively add a certain percentage to P_{fr} to allow for it. The back-pressure of the air in the die cavity P_a is also a relatively small factor of which we shall not take account. It may be ascertained from the formula $P_a = F_s \times p_a$, where p_a is the resistance of the air in kg./cm.^{2}.

Let us take, for example, $F_s = 9{\cdot}8$ cm.^{2}, and $p_a = 5$ kg./cm.^{2}; then $P_a = 9{\cdot}8 \times 5 = 49$ kg., which is negligible.

Thus we arrive at the following balance-of-forces equation:

$$P_{np} = P_{fr} + P_{in}, \text{ in kg.} \quad \text{........................(3)}$$

According to the laws of hydraulics, the frictional force is determined by

$$P_{fr} = F_{cy} \cdot p_{fr} = F_{cy} \cdot H\gamma'_1 \text{ in kg.} \quad \text{.........(4)}$$

where

F_{cy} = the area of the transverse section of the shot sleeve in m.^{2}
p_{fr} = the total pressure arising from the frictional force, in kg./m.^{2}
H = the loss of energy in the jet, in metres, *i.e.* loss of head.

The loss of energy in the metal stream is determined by the general formula

$$H = \left[\sum_{i=1}^{i=n} \zeta'_i\delta^2_i + \sum_{i=1}^{i=m} \zeta''_i\delta^2_i\right] [w^2_{cy}/2g] \text{ in metres} \quad \text{..........................(5)}$$

or,

$$H = \zeta_s[w^2_{cy}/2g] \text{ in metres} \quad \text{....................(6)}$$

with

$$\zeta_s = \sum_{i=1}^{i=n} \zeta'_i\,\delta^2_i + \sum_{i=1}^{i=m} \zeta''_i\,\delta^2_i \quad \text{.................. (6a)}$$

where

ζ'_i = coefficient of resistance due to friction within the jet.
ζ''_i = coefficient of resistance due to local impediments to flow.
w_{cy} = average velocity of metal displacement within the shot-sleeve, m./sec.
$g = 9{\cdot}81$ m./sec.^{2} = gravitational acceleration.
ζ_s = calculated coefficient of resistance within the system.

The coefficient δ_i represents the relation between the cross-sectional area of the shot sleeve and the cross-sectional area of the metal stream at a particular point along its length, i.e.

$$\delta_i = F_{cy}/F_i \quad \text{.....(7)}$$

The coefficients ζ'_i and ζ''_i can be found in manuals on hydraulics. Although the values in such manuals refer to the properties of water, they may nevertheless be used as approximations for molten metals.

Equation (5) may be written

$$H = H' + H'', \text{ in metres} \quad \text{.....(8)}$$

with

$$H' = [w^2_{cy}/2g] \sum_{i=1}^{i=n} \zeta'_i \, \delta^2_i \quad \text{.....(9)}$$

To represent the loss of head, for a given length of flow, in metres

$$H'' = [w^2_{cy}/2g] \, \zeta''_i \, \delta^2_i \quad \text{.....(10)}$$

which represents the total loss of head from all local impediments to flow.

The coefficient of frictional resistance is determined by the relation

$$\zeta'_i = \lambda_i l_i / d_i \quad \text{.....(11)}$$

where

λ_i = a coefficient depending upon the character of flow, of which the Reynold's Number is the criterion.

l_i = length of channel through which the metal flows, in metres.

d_i = the diameter of the channel, in metres.

λ_i is determined according to well-established formulae: [see, for example, "A Small Manual of Hydraulics," by Pavlovsky (Stoisdat. 1940)]. The value of this coefficient is much less than unity. Making use of Prandtl's relation, we find that, when the Reynolds number varies between 4,000 and 3,500,000, the coefficient λ_i varies between 0·0400 and 0·0095. The Reynolds number is itself determinable from

$$R_e = \gamma'_1 w_i \, d_i / g\mu \quad \text{.....(12)}$$

where w_i = the velocity of metal flow in the specified length of channel, in m./sec.; and μ = the coefficient of viscosity of the molten metal in kg./sec./m.^{2}

The force of inertia P_{in} that occurs in equation (3) is determined by Newton's law,

$$P_{in} = m_{np} \cdot a = (G_{np}/g) \, a, \text{ in kg.} \quad \text{......(13)}$$

where $m_{np} = G_{np}/g$ = the mass of the plunger, the hydraulic piston and rod, and the hydraulic medium in the injection cylinder; and G_{np} = the weight of the plunger, piston and rod.

The acceleration a acting on the plunger is a function of plunger velocity, calculated thus:

$$a = w'^2_{cy}/2h, \text{ in m./sec.}^2 \quad \text{.....(14)}$$

or,

$$a = w''^2_{cy}/2s'', \text{ in m./sec.}^2 \quad \text{.....(15)}$$

where h = the free stroke of the plunger in metres; s'' = the total stroke of the plunger in metres; w'_{cy} = the velocity of the plunger as the metal begins to enter the die, in m./sec.; and w''_{cy} = the velocity of the plunger as the filling is completed, in m./sec.

These calculations show that the velocity of metal displacement in the shot sleeve varies only slightly during the casting process, and to simplify analysis, it is justifiable to treat it as a constant. The mean velocity of displacement is determined by

$$w_{cy} = (w'_{cy} + w''_{cy})/2, \text{ in m./sec.} \quad \text{...(16)}$$

The acceleration a can be then approximately represented by

$$a = w_{cy}^2/2h_{sp} = w_{cy}^2/(2h + s) \text{ in m./sec.} \quad \text{...(17)}$$

where $h_{sp} = h + s/2$ = the mean stroke of the plunger, in metres; and $s = s'' - h$ = the effective stroke of the plunger, during which metal is being forced into the die, in metres.

Substituting the value of a given by equation (17) in expression (13), we obtain the inertia force as a function of the velocity,

$$P_{in} = [G_{np}/g] \, [w_{cy}^2/2h_{sp}], \text{ in kg.} \quad \text{.........(18)}$$

Recapitulating the balance-of-forces equation, using expressions (4), (6) and (18), we obtain

$$P_{np} = [F_{cy} \cdot \gamma'_1 \cdot \zeta_s] \, [w_{cy}^2/2g] + [G_{np}/g] \, [w_{cy}^2/2h_{sp}], \text{ in kg.} \quad \text{......(19)}$$

This gives a value of P_{np} for the mean plunger velocity w_{cy}. At the moment when the metal enters the die, the relevant conditions are given by

$$P_{np} = [F_{cy} \cdot \gamma'_1 \cdot \zeta_s] \, [w'^2_{cy}/2g] + [G_{np}/g] \, [w'^2_{cy}/2h], \text{ in kg.} \quad \text{......(20)}$$

Here, the sum of the coefficients of resistance refers to the metal-injection mechanism, since there is as yet no resistance within the die cavity. At the end of the injection stroke, the conditions are

$$P_{np} = [F_{cy} \cdot \gamma'_1 \cdot \zeta_s] \, [w''^2_{cy}/2g] + [G_{np}/g] \, [w''^2_{cy}/2S''], \text{ in kg.} \quad \text{......(21)}$$

Here, the coefficient ζ_s is obtained by adding together all the resistances in the shot-sleeve, sprue orifice, runner channel and cavity.

The relations thus obtained allow us to determine the hydrodynamic characteristics of the injection process with respect to frictional and inertia forces, also to ascertain the rates of metal flow in the shot-sleeve. From equations

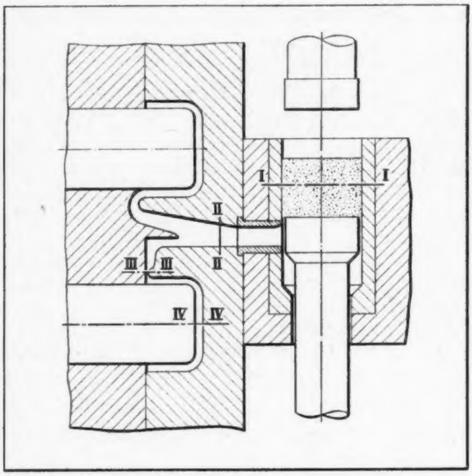


Fig. 1. Typical die casting die showing (upper portion) cavity gated without constriction and (lower portion) with normal type of gate

(19), (20) and (21), we obtain

$$w_{cy} = \sqrt{[2gP_{np}/(F_{cy}\gamma'_1\zeta_s + G_{np}/h_{sp})]} \text{ in m/sec.} \quad \dots\dots\dots\dots\dots(22)$$

$$w'_{cy} = \sqrt{[2gP_{np}/(F_{cy}\gamma'_1\zeta_s + G_{np}/h)]} \text{ in m/sec.} \quad \dots\dots\dots\dots\dots(21)$$

$$w''_{cy} = \sqrt{[2gP_{np}/(F_{cy}\gamma'_1\zeta_s + G_{np}/s'')]} \text{ in m/sec.} \quad \dots\dots\dots\dots\dots(22)$$

Making use of the velocities already ascertained, we can now calculate the process of cooling in the die. To make this calculation we must know the size and shape of the die, and Fig. 1 shows a stylized die for a vertical pressure chamber machine. The upper part of the figure corresponds to conditions of metal entry with minimum friction, and the lower cavity, with its restricted gate, to an appreciable degree of friction.

For simplicity, we shall examine three sections only: I–I, across the shot-sleeve; II–II, across the runner leading to the cavity; III–III, across the constricted gate where the runner joins the cavity. The area of section I–I for a diameter of 50 mm. is $F_{cy} = 19 \cdot 6$ cm.^{2} Let us take the area of section II–II as $F_{II} = 4 \cdot 9$ cm.^{2} Let the section across the gate, III–III, be $F_{III} = 1 \cdot 96$ cm.^{2}, *i.e.* half the area of the shot-sleeve (or the plunger tip). F_{III} is then 20 per cent of F_{cy}.

Under these conditions, the coefficient ζ_s—necessary for the calculation of the rate of flow according to equations (22) and (24)—is the sum of the following resistances.

The local impediments to flow are: ζ''_1, the inlet from the injection chamber to the sprue-hole; ζ''_2, the 90-deg. angle at the junction of the sprue-hole and runner-channel; ζ''_3, the constriction of the gate; and ζ''_4, the sudden widening of the metal stream as it enters the cavity. These specified resistances are effective at the moment that the metal starts to pass through the gate into the cavity, and permit us to ascertain the initial velocity of the metal stream. As the cavity is filled, resistances within the cavity also become effective. Accordingly, the movement of the inflowing metal is retarded as filling progresses.

It is of interest to ascertain the initial speed w'_{cy} and the final speed w''_{cy} when the hydrodynamic resistances of the cavity are added to those in the approach channels. The arithmetical mean of these two values can then be taken as the average speed of flow in our further calculations. For simplicity, we shall only calculate in our example the initial velocity, w'_{cy} of the metal. The sum of the local resistances is determined by the general formula

$$\zeta''_s = \sum_{i=1}^{i=m} \zeta''_i \delta^2_i \quad \dots\dots\dots\dots\dots\dots\dots(25)$$

which in our example takes the form

$$\zeta''_s = \zeta''_1 [F_{cy}/F_{II}]^2 + \zeta''_2[F_{cy}/F_{III}]^2 + \zeta''_3[F_{cy}/F_{III}]^2 + \zeta''_4[F_{cy}/F_s]^2 \quad \dots\dots(25a)$$

In Pavlovsky's "Manual" we find for the entry to the sprue-hole, $\zeta''_1 = 0 \cdot 5$; for the 90-deg. turn, $\zeta''_2 = 0 \cdot 98$; for the narrowed gate, $\zeta''_3 = 0 \cdot 35$, and for the sudden expansion,

$$\zeta''_4 = [F_s/F_{III} - 1]^2 = [(9 \cdot 8/1 \cdot 96) - 1]^2 = 16.$$

Summing the foregoing, we obtain

$\zeta''_s = 0 \cdot 5 \ (19 \cdot 6/4 \cdot 9)^2 + 0 \cdot 98 \ (19 \cdot 6/1 \cdot 96)^2 + 0 \cdot 35 \ (19 \cdot 6/1 \cdot 96)^2 + 16 \ (19 \cdot 6/9 \cdot 8)^2 = 205$, which is accordingly the approximate sum of local resistances to flow.

To find the overall value of the resistances in the system, it is necessary in addition to take account of friction in the metal stream:

$$\zeta'_s = \sum_{i=1}^{i=n} \zeta'_i \delta^2_i \quad \dots\dots\dots\dots\dots\dots\dots(26)$$

In practice, this factor is commonly very much less than that due to local changes of direction or section, and may usually be ignored. An example will substantiate this statement. Assuming for simplicity that the channel is of constant section equal to the section of the casting ($F_s = 9 \cdot 8$ cm.^{2}), the length of the metal stream 215 mm. ($= 0 \cdot 215$ m.), and the velocity of the metal—needed for the calculation of the Reynolds Number—is 38·4 m/sec. For dimension d_i, in equation

(12), we take the thickness of the casting as $d_i = 2X_1 = 4$ mm. $= 0{\cdot}004$ m. Lastly, the coefficient of viscosity μ will approximate to 300×10^{-6} kg./sec./m.[2] Then the value of the Reynolds number will be

$$\begin{aligned} R_e &= (\gamma'_1 w.2X_1/g\mu) \\ &= (2{,}380 \times 38{\cdot}4 \times 0{\cdot}004)/(9{\cdot}81 \times 300 \times 10^{-6}) \\ &= 124{,}000 \end{aligned}$$

For this value of R_e, the corresponding retardation factor $\lambda = 0{\cdot}017$ (Pavlovsky, *op. cit.*) and from equation (11) we are now able to calculate the resistance due to friction within the metal stream

$$\zeta' = \lambda l/2X_1 = (0{\cdot}017 \times 0{\cdot}215)/(0{\cdot}004) = 0{\cdot}91.$$

Transferring this value to (25) gives us the sum of all the frictional resistances

$$\zeta'_s = \zeta' \, (F_{cy}/F_s) = 0{\cdot}91 \, (19{\cdot}6/9{\cdot}8) = 1{\cdot}82.$$

It is thus evident that loss of head due to friction within the metal stream is indeed negligible compared with losses due to local impediments to flow, which is explained by the shortness of the feed system and the relatively large number of changes in direction and section which occur in it. Whilst a more precise calculation of internal friction might yield a slightly different value for ζ'_s, it would remain of the same order of magnitude.

In the example above, therefore, the total resistance in the system is represented by a factor

$$\zeta_s = \zeta'_s + \zeta''_s = 1{\cdot}82 + 205 = 207.$$

According to (23), we now find the velocity of the metal stream in the shot-sleeve at the moment that the cavity begins to fill, w'_{cy}. Taking $P_{np} = 15{,}000$ kg.; $G_{np} = 100$ kg.; $h = 0{\cdot}1$ m., and $\gamma'_1 = 2{,}380$ kg./m.[3] (for aluminium alloy), then the velocity of flow is

$$\begin{aligned} w'_{cy} &= \sqrt{[(2 \times 9{\cdot}81 \times 15{,}000)/(0{\cdot}00196 \times 2{,}380 \times 207 + 100/0{\cdot}1)]} \\ &= 12{\cdot}2 \text{ m./sec.} \end{aligned}$$

Before going on to analyse metal-flow temperature characteristics along the lines indicated by (1), let us examine the variation in metal temperature caused by friction of the stream against the die surfaces. A value for this is given by (4), and by combining (4), (6), (22), (23) and (24), we obtain

$$P_{fr} = F_{cy} \cdot \gamma'_1 \cdot \zeta_s (w^2_{cy}/2g) \text{ in kg.} \quad \ldots\ldots\ldots(27)$$
$$P_{fr} = F_{cy} \cdot \gamma'_1 \cdot \zeta_s (w'^2_{cy}/2g) \text{ in kg.} \quad \ldots\ldots\ldots(28)$$
$$P_{fr} = F_{cy} \cdot \gamma'_1 \cdot \zeta_s (w''^2_{cy}/2g) \text{ in kg.} \quad \ldots\ldots\ldots(29)$$

Friction within the metal stream is a factor of considerable importance in the analysis, as may be judged from the fact that, if we calculate the velocity of flow w_{cy} on the hypothesis that no frictional losses occur, the value of $12{\cdot}2$ m./sec. is raised to $17{\cdot}1$ m./sec. The loss of head due to friction conduces to an appreciable lowering of the metal velocity in the shot-sleeve, and consequently of the velocity with which the stream enters the die cavity.

With this lowering of the velocity of influx, there is a comparable reduction in the temperature of the metal passing the gate (because the time during which heat transfer can occur, per unit volume to unit surface of the shot-sleeve, is greater) and one might accordingly expect defective flow to occur as a result of this heat loss.

In fact, this defective flow does not occur, because the friction which causes the lowering of velocity is itself transformed wholly into heat, and so brings about an increase in metal-stream temperature. The fluidity and other desirable characteristics of the injected metal are thus not impaired.

In this way, when the gate is narrow and the velocity of influx much reduced, the more rapid cooling is compensated by the accession of frictional heat. When frictional forces are very large, this heating effect is so great that it becomes possible to inject metal almost entirely without initial superheating. Moreover, loss of superheat in the shot-sleeve prior to injection may be made good by the temperature rise resulting from friction when movement of metal begins. The effect of this thermal factor can be determined by reference to the following considerations. The frictional work L_{fr} is the product of the force P''_{fr} and the distance s moved by the injection plunger during the actual filling of the cavity; that is

$$L_{fr} = P''_{fr} s \text{ in kg.-metres} \quad \ldots\ldots\ldots\ldots(30)$$

It is usual to choose as the value for P''_{fr} a force which depends only upon the retarding effect of the gate. The other impediments to flow also contribute to the heating of the metal stream, but their total effect is diminished by the fact that, since they operate while the metal is in contact with the walls of the runner channel, some of the heat gained is lost again before the gate is reached. The gate itself being directly adjacent to the cavity, loss of heat thereafter is negligible and adiabatic flow may be assumed. It is important to bear in mind that when the gate is narrow all other resistances to flow are negligible in comparison with the effect of retardation in the gate. The final resistance ζ_s of the whole metal-feeding system thus becomes, in practice, substantially equivalent to the resistance to flow at the gate

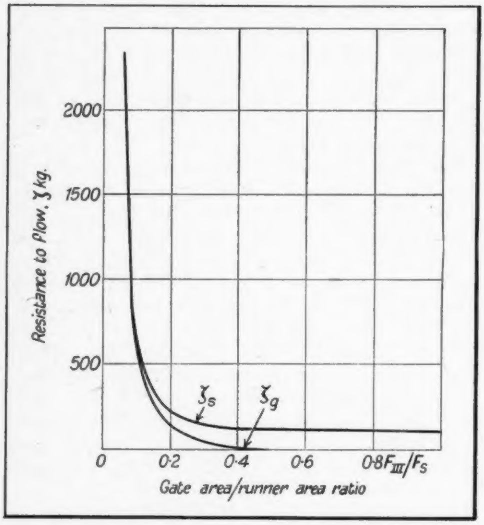


Fig. 2. Resistance to flow falls sharply as the ratio of gate depth to runner depth increases. Most of the resistance occurs in the gate (lower curve); the total resistance of the system (upper curve) is only slightly greater

$$\zeta_g = \zeta''_3(F_{cv}/F_{III})^2 + \zeta''_4(F_{cv}/F_s)^2 \ldots\ldots (31)$$

The influence of the relation (F_{III}/F_s) on the resistance ζ_g at the gate is depicted in Fig. 2. Clearly, the frictional force P''_{fr} is related to the frictional force P_{fr} thus:

$$P''_{fr} = P_{fr}\ (\zeta_g/\zeta_s) \text{ in kg} \ldots\ldots\ldots\ldots\ldots\ldots (32)$$

When the gate is narrow, the ratio (ζ_g/ζ_s) is virtually unity.

For s in equation (30), we divide the effective volume of the casting, runner and sprue (ignoring the slug left in the shot-sleeve) by the cross-sectional area of the bore of the sleeve, in order to obtain the working stroke, *i.e.*

$$s = V'_1/F_{cv} \text{ in metres} \ldots\ldots\ldots\ldots (33)$$

Substituting in (30) according to (33) we obtain

$$L_{fr} = P''_{fr}\ (V'_1/F_{cv}) \text{ in kg.-metres} \ldots\ldots (34)$$

The whole of the energy L_{fr} is changed into heat Q_{fr}, that is

$$Q_{fr} = AL_{fr} \ldots\ldots\ldots\ldots\ldots\ldots (35)$$

where $A = 1/427$ kcal./kg. = the thermal equivalent of energy.

The heat Q_{fr} raises the temperature of the metal by Δt. The quantity Q_{fr} of heat can be expressed as a function of the specific heat of the die-casting alloy and of Δt. We have then

$$Q_{fr} = V'_1 \cdot \gamma'_1 \cdot C'_1\ \Delta t \text{ kcal} \ldots\ldots\ldots\ldots\ldots (36)$$

where C'_1 is the specific heat of the liquid alloy in kcal./kg./deg. C. If the die-casting alloy is at a temperature below the liquidus in the section of the runner preceding the gate, then the heat needed for the whole mass to regain liquidus temperature is included in C'_1.

If in equation (35) we replace L_{fr} and Q_{fr} by their values according to (34) and (36), we obtain the increase in metal temperature as the stream passes through the gate.

$$\Delta t = (1/427)\ (P''_{fr}/F_{cv}\,\gamma'_1\,C'_1) \text{ in deg. C.} \ldots (37)$$

Equation (34) may also be written

$$\Delta t = (1/427)\ (P''_{fr}s/G_1C'_1) \text{ in deg. C.} \ldots\ldots (38)$$

where G_1 is the weight of the casting, runner and sprue (but not the slug) in kg.

Equations (37) and (38) provide a relation between the temperature rise in the die-casting alloy and the several parameters of the injection process. The frictional force P''_{fr} is the most important factor. Δt increases as P''_{fr} increases. It is clear that, with a very narrow gate, the force P''_{fr} becomes equal to the pressure P_{fr}. Under these conditions, equations (37) and (38) have the limiting forms

$$\Delta t = (1/427)\ (P_{np}/F_{cv}\gamma'_1C'_1) \text{ in deg. C.} \ldots\ldots (37')$$

$$\Delta t = (1/427)\ (P_{np}s/G_1C'_1) \text{ in deg. C.} \ldots\ldots\ldots (38')$$

These latter equations give the greatest possible increase in temperature that can occur in the molten alloy as it enters the die cavity.

We may now calculate this temperature rise in the example already considered. From (28) we obtain the value of P_{fr}.

$$P_{fr} = 0{\cdot}00196 \times 2{,}380 \times 207 \times (12{\cdot}2^2/2 \times 9{\cdot}81) = 7{,}400 \text{ kg.}$$

From (32) we obtain the frictional force P''_{fr}, with $\zeta_g = 99$.

$$P''_{fr} = 7{,}400\ (99/207) = 3{,}540 \text{ kg.}$$

Equation (37) now gives us the increase in temperature

$$\Delta t = (1/427)\ [3{,}540/(0{\cdot}00196 \times 2{,}380 \times 0{\cdot}308)] = 5{\cdot}8 \text{ deg. C.}$$

In practice, the temperature rise Δt may somewhat exceed this value, since not all of the heat resulting from frictional losses in the runner system is likely to have been transmitted to the die before the gate is reached. If, in the limit, we assume that no heat is lost to the die but that the flow is adiabatic throughout, we must replace P''_{fr} by P_{fr} in equations (37) and (38).

In our example, using an aluminium alloy, we find that

$$\Delta t = (1/427)\ (P_{fr}/F_{cv}\gamma'_1 C'_1)$$
$$= (1/427)\ [7{,}400/(0\cdot00196 \times 2{,}380 \times 0\cdot308)]$$
$$= 12\cdot1 \text{ deg. C.}$$

On this basis, the limiting increase of temperature with a very narrow gate is ascertainable from (37′)

$$\Delta t = (1/427)\ [1{,}500/(0\cdot00196 \times 2{,}380 \times 0\cdot308)] = 24\cdot5 \text{ deg. C.}$$

It is impossible, under the conditions here examined, to obtain a greater increase in temperature than the figure given, however constricted the gate. This point will be clear from an examination of Fig. 3, which shows the influence which the ratio (F_{III}/F_s) has on the value of Δt.

The calculations are in accordance with equation (37). As the figure shows, a considerable increase in temperature is only observed when the gate is narrow—effectively, only when (F_{III}/F_s) is less than 1/5. In Fig. 3, the broken line shows how Δt varies when all the heat arising from frictional losses is taken into account; i.e. when P''_{fr} is replaced by P_{fr}. However, in the part of the graph where the temperature rise is greatest, the divergence of the two curves is least, and when the ratio (F_{III}/F_s) is very small, it is friction in the gate that is of dominant importance. In practice, one may accordingly take the value of P''_{fr} rather than that of P_{fr} as indicating the temperature rise. This latter is in fact more likely (because of heat losses occurring in the runner channel) to provide an accurate measure of increase.

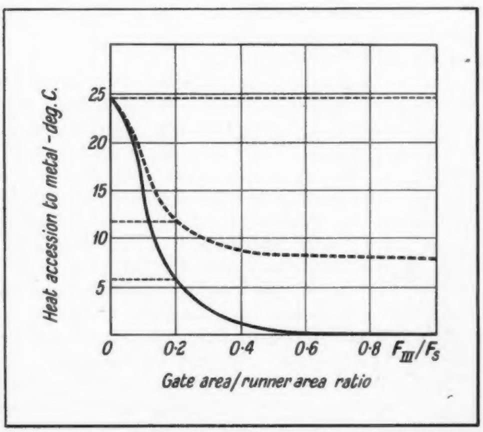


Fig. 3. Heat accession to the metal, due to fluid friction, results in a temperature rise as the metal passes the gate, and this rise is greatest when the gate is narrow compared to the runner. The full curve shows the temperature rise if the heat accession at the gate alone is considered. With the dotted curve, account is taken of all frictional losses and it is assumed that there is no net transfer of heat to the die from the runner surfaces

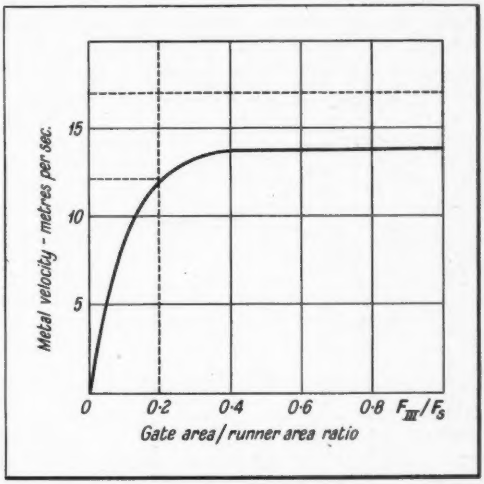


Fig. 4. This curve shows the relation of metal velocity to the ratio of gate-area to runner-area

From the above analysis, it will be clear why certain die casters tend to use shallow gates. A reduction in the value of F_{III} results in a considerable temperature rise due to friction at the gate. This rise improves the fluidity of the metal immediately prior to its entry into the cavity, and so promotes conformity to the finest details of the impression. Moreover, this practice permits lower ladling temperatures to be employed, which also tends to improve the quality of the resulting die castings.

It is of greatest importance, nevertheless, not to lose sight of the fact that the use of narrow gates also has other consequences. Reduction of the gate depth tends to heat the metal, due to frictional effects, but the reduction in cross-sectional area also lowers the filling rate. (The *rate* of fill, cm.^{3}/sec., must be distinguished from the *velocity* of the flow of metal in the gate, cm./sec.).

Metal therefore remains longer in contact with the walls of the feed channels and so loses more heat before reaching the gate. As this loss directly counters the frictional effects, it is of great interest to make a comparative analysis of the relative influence of the two factors on thermal conditions.

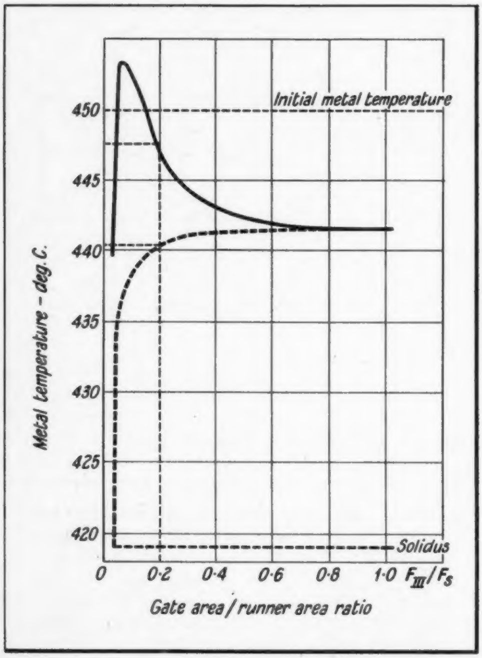


Fig. 5. Temperature of metal passing the gate without heat accession from friction (dotted curve) and when allowance is made for the effect of friction (full curve)

From the relations already established, we can readily estimate the effect of accessions of heat to, and losses of heat from, the metal stream in the die during injection. While the cavity is filling, the frictional effects impose velocity changes, and it is accordingly necessary to calculate heat losses corresponding to a range of filling rates. Fig. 4 shows the effect of the relation (F_{III}/F_s) upon the velocity of the plunger, the broken line corresponding to flow without frictional resistance as in Fig. 1 (top), taking $w'_{cy} = 17\cdot1$ m./sec.

At the moment when the cavity is completely filled, the metal stream varies in temperature along its length. At the gate, the temperature is equal to the initial temperature t_1*init.*, whilst at the end of the cavity it is near the solidus t_{cr}. Taking, in our example, $b_2 = 176$ kcal./m.²/hr./deg. C.; $t_\phi = 250$ deg. C.; $R_s = 2$ mm., since the thickness of the casting is 4 mm.; and $C'_1 = 0\cdot308$ kcal./kg./deg. C., the value for molten aluminium, then equation (1) gives us the temperature t_1 of the metal at cross-section z:

$$t_1 = t'_1 \, init. - \frac{176\,(t'_1 \, init. - 250)}{1\cdot77 \times 0\cdot002 \times 2{,}380 \times 0\cdot308} \times \frac{0\cdot107 - 0\cdot0535}{\sqrt{(0\cdot0535 w)}}$$

$$= t'_1 \, init. - (15\cdot7t'_1 \, init. - 250)/(\sqrt{w}) \text{ deg. C.}$$

The solid line in Fig. 5 gives t_1 according to this relation. The velocity w is expressed in metres per hour, calculated from $w = w_{cy}(F_{cy}/F_s)$ according to the values given in Fig. 4.

The curves shown in Fig. 5 are of great interest. We see that, as the gate becomes narrower, the accession of heat and the consequent temperature rise are at first small, but become continually more important until, at a gate-section/casting-section ratio of a little less than 1/10, the rise in temperature attains a maximum. Thereafter, it drops extremely rapidly with further reduction in gate depth. This drop results from a sharp reduction in the velocity of flow when the gate is made very shallow, the transmission of heat to the die then becoming the more important factor.

In Fig. 5, the broken line represents the temperature of the metal if, as in the layout indicated in the upper part of Fig. 1, there are no constrictions or other impediments to flow which can give rise to frictional heat, and this line falls considerably below the solid curve. It follows that, for equal velocities of influx, the thermal characteristics of the metal forced through a restricted gate are superior to those achieved where no frictional losses occur. However, if all other factors are constant, the velocities of influx in the two cases are not, in fact, equal. In particular, if the metal flows with minimum friction, the heat loss to the die is not very large.

In the example already taken, the mean velocity of flow for an aluminium alloy, without taking into account frictional effects, is $w = 38\cdot4$ m./sec. Under these conditions, the temperature of the middle section of the casting at the moment filling is completed reaches the value $t_1 = 681$ deg. C. This result confirms the considerations just mentioned. In fact, in the absence of frictional losses, the metal gains no heat while flowing into the cavity, but the rate at which the die abstracts heat from the metal is increased and the thermal gradient along the die cavity is minimized.

It is essential to note that if absolutely frictionless metal flow were achieved, the velocity of the plunger could readily be increased without increasing the available hydraulic pressure, by such measures as reducing the weight of the plunger or increasing its velocity during the initial—" free "—part of the stroke h. With

frictional resistances to metal flow, increased plunger speed is obtainable only by increasing the pressure behind it.

The theoretical considerations investigated in this survey allow the most efficient conditions for cavity-filling to be investigated for each individual die casting. Not every aspect of the process, however, has been taken into account here. For example, the question of the effect of influx velocity upon the quality of the resulting die casting remains unresolved. However, the chief parameters of the process have been examined, and the die caster may adopt in their entirety the relations here set out when designing die casting dies or machines.

In working out the hydrodynamics of the metal injection process by means of the relations given, it is important to take into account the following considerations. The formulae in hydraulics taken from Pavlovsky were established for applications where steady-flow conditions applied. Such a flow is, however, only achieved at the cost of considerable friction. Where friction is small, the inertia forces become of some importance, since major velocity components may act in directions other than the direction of flow. Calculation therefore gives only approximate values for frictional forces, although in practice the relations cited will yield results sufficiently accurate.

In calculating the velocity of metal influx, taking into account the effect of friction, it suffices to calculate only the initial velocity w'_{cy} as in our example. The final speed w''_{cy} need not be worked out, for inasmuch as friction occurs also in the process of filling the cavity, the resistance of the cavity itself must be added to the resistance of the runner system. In consequence, the final speed is, in fact, a little less than calculation would indicate. The velocity at the end of injection, however, only slightly exceeds the initial velocity in any case, so that in calculating with the former alone we shall not—although it is a hydrodynamic function of the feed system only—introduce any great error. We shall, on the other hand, greatly simplify our computations.

With a great deal of friction because of a shallow gate, it is practicable to take account in the calculations of the resistance to flow within the gate alone, disregarding frictional effects in runner and cavity. Very careful attention must be paid to the design of hydraulic systems for die casting machines, because the considerations brought out above as applying to the thermodynamic relations of the die-casting alloy also apply to the machine hydraulics.

Frictional losses taking place in the hydraulic medium are as important as similar losses in the injected metal (and, like them, lead to heating of the medium). Faulty design of the hydraulic system may fundamentally affect the hydrodynamic relations, and consequently alter the results obtained. Machine hydrodynamics are precisely parallel to metal hydrodynamics as here discussed, and will not be separately treated.

Rocol R.T.D. Spray

Rocol R.T.D. compound is now being marketed by Rocol, Ltd., Swillington, Nr. Leeds, in aerosol containers under the name R.T.D. Spray. With such a container, a film of this 100 per cent additive compound can readily be applied to cutting and forming tools, as shown for example in the illustration. As compared with the use of a brush, this method is claimed to ensure more effective penetration down the flutes of tools and into die heads. It also offers advantages where it is required to coat forming tools or dies, or to apply compound to moving workpieces.

Good results are reported to have been obtained from R.T.D. Spray in connection with a variety of operations including drilling, tapping, screw-cutting, sawing, slot-milling, and boring, particularly on such materials as stainless steel.

Application of Rocol R.T.D. Spray to a die-head

British-built Cincinnati Grinders

The range of machine tools built by Cincinnati Milling Machines, Ltd., Kingsbury Road, Birmingham, 24, is to be expanded to include plain and universal cylindrical grinding machines, in addition to the centreless types already produced by the company. This announcement was made recently at the Birmingham works by Mr. Clifford R. Meyer, managing director of the company, who pointed out that the new machines would be built at the Biggleswade factory of Weatherley-Cincinnati, Ltd. The machines which are to go into production initially are 10- and 14-in. plain hydraulic grinders and 14- and 18-in. universal grinders, and all will be available with a range of table sizes. During 1962, the range will be augmented by the addition of travelling-table and travelling-wheelhead roll grinding machines.

Sales of British-built Cincinnati grinding machines will be handled by Chas. Churchill & Co., Ltd., Coventry Road, Birmingham, 25, who have sold Cincinnati milling, broaching, and other machines for many years. To assist in the marketing of grinding machines and to provide technical assistance, Mr. Walter W. Zorich has been appointed manager, grinding sales, Cincinnati Milling Machines, Ltd. Mr. Zorich joined the American Cincinnati company in 1948 and has specialized in the firm's grinding machines for the past nine years.

Following the announcement by Mr. Meyer, the president of the American company, Mr. S. E. Bergstrom, referred to the growth of the British organization. The building of milling machines was started at Birmingham in 1934, and was followed by the building of centreless grinders, and later by the production of broaching machines. The American company had been very pleased with the results of its association with Great Britain, and with Chas. Churchill & Co. It was felt that the range of machines built in this country should be broadened, and it was hoped that all the machines produced in the U.S.A. would eventually be built here. Cincinnati considered that they had much to contribute to the knowledge and application of grinding techniques, based on the experience which had been gained in this field, and that the building of centre-type grinding machines at Biggleswade would benefit not only the company but also British industry.

The grinding machines to be built in this country were demonstrated at the Birmingham works. All machines have wheelheads incorporating the company's Filmatic bearings, and automatic wheel balancing equipment is provided whereby the abrasive wheel can be balanced in 20 sec. without removing it from the machine. Plain grinding machines can be supplied to accommodate workpieces up to 96 in. long. An extensive range of additional equipment is available, including a push-button actuated, automatic dual-rate infeed unit; a gap-eliminator arrangement whereby the wheel is automatically brought rapidly into contact with the work, regardless of diameter variations; behind-the-wheel profile truing equipment; and the company's Acrasize air-electric gauge sizing unit.

A swing-down internal spindle is provided on the universal machines, and the work-speeds are steplessly variable. Additional equipment includes a Gage-Line electronic attachment for measuring the swing of the swivel table, which enables correction to be made for workpiece taper to fine limits of accuracy. This unit is also available for plain grinding machines.

Other Cincinnati grinding machines that were demonstrated included the No. 1 Microcentric type for grinding the tracks of ball races, which was fitted with twin-arm automatic loading equipment and Acrasize gauging equipment. This machine has a rocking wheelhead, and the work is supported on tungsten carbide shoes, with automatic compensation for the material removed during grinding. Provision is made for automatic truing of the wheel after a pre-set number of components has been ground. A similar machine can be supplied for chucking operations, and has two work spindles incorporated in a drum which is automatically indexed, so that the diaphragm chuck on one spindle can be loaded while the component in the other chuck is being ground.

Diamond as a Thermistor Material. In a booklet recently issued by The Industrial Diamond Information Bureau, reference is made to the work of the Diamond Research Laboratory in Johannesburg, in connection with new applications for diamond. It is pointed out, for example, that whereas most diamonds are perfect electrical insulators, it has recently been ascertained at the Laboratory that a certain type of stone (known as type II b) has semi-conducting properties which make it very suitable for use as a thermistor. Diamonds of this type which are found in some South African mines, and are usually blue in colour, can, it is stated, be used to measure temperature changes as small as 0·002 deg. C.

New Factory for Whiteley, Lang & Neill, Ltd.

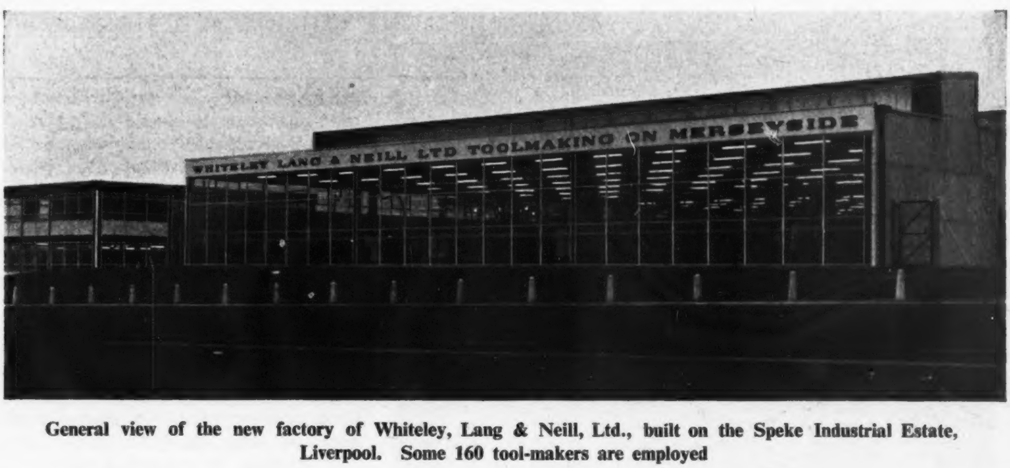
A new factory, a general view of which is given in the accompanying illustration, occupied by the lately-formed company of Whiteley, Lang & Neill, Ltd., was recently opened by the Rt. Hon. Lord Mills, P.C., K.B.E., Her Majesty's Minister without Portfolio, on the Speke Industrial Estate, at Speke Hall Road, Liverpool, 24, and facilities were afforded for inspection of the premises. The firm, of which James Neill & Co. (Sheffield), Ltd., is the parent organization, is an amalgamation of two businesses from the Merseyside area, known as Lang Precision Engineering, Ltd., and Whiteley Mills, Ltd., all three companies having been established for more than 50 years.

Lang Precision Engineering, Ltd., was founded in 1896, and was originally concerned mainly with the production of pen nibs. The high standards of precision required in the tools for this work led the firm to concentrate almost exclusively on tool-making during recent years. Whiteley Mills, Ltd., occupied premises forming part of the Lang factory when the business was started in 1906, and after making toys and radio components, this firm also began to concentrate on tool-making. James Neill & Co. (Sheffield), Ltd., was established in 1889 to make special tool steel, and the range of products has since been extended to include many types of hand tools and associated factory equipment.

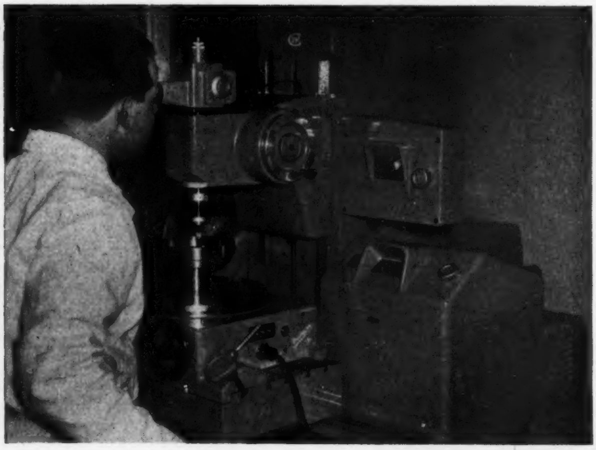
The first two firms have now joined their resources, with capital provided largely by the parent company, and have moved into the new factory, which is situated close to Liverpool Airport. Most of the buildings are arranged for under-floor heating by means of electrical elements embedded in the floors, and the main building, seen in the figure, is of glass-walled construction at one side, jig-boring and jig grinding machines being situated in this area to take advantage of the good lighting. This building measures some 250 by 120 ft., and the area available has enabled machines of various types to be concentrated in sections in lines which extend parallel to the short sides. The arrangement of the machines was planned with the aid of models to the scale of ⅜ in. to 1 ft., supplied by Visual Planning Systems, Ltd., and was carried out by the apprentices.

To the left in the illustration is a square, 2-storey block, containing the drawing, planning and costing offices. Rank-Xerox plan copying equipment is employed for the production of reduced-scale prints to be used in the factory, and micro-film copying equipment is also installed in the drawing office. In the planning and costing offices, I.C.T. punched card equipment is provided for such purposes as control of work in progress, job costing, estimates of forward loading of the various machine sections, and the preparation of a weekly summary of the production position. In the planning section, times for making various individual items of a tool are provided by

(*Continued on page* 1514)

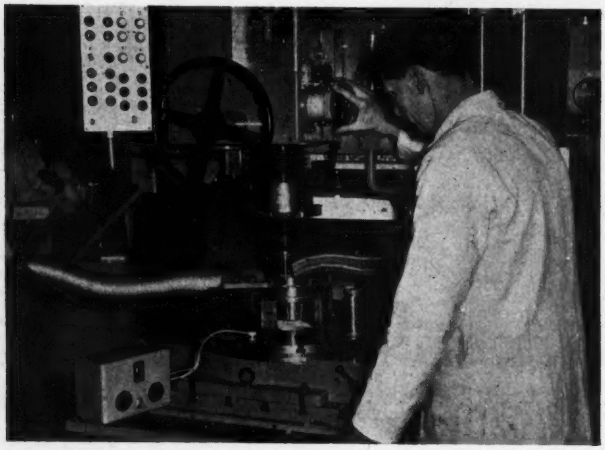


General view of the new factory of Whiteley, Lang & Neill, Ltd., built on the Speke Industrial Estate, Liverpool. Some 160 tool-makers are employed



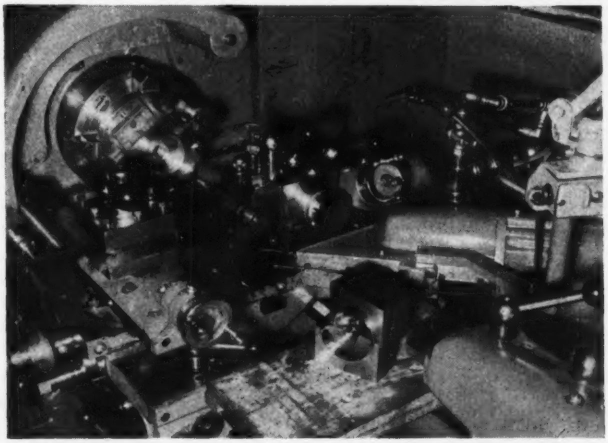
Claimed to be the only machine of its type so far installed in this country, the Société Genevoise Trioptic universal measuring machine, here seen set up for checking a drive head component, forms part of the equipment in the temperature- and humidity-controlled standards room. The machine is arranged for metric measurement, and is to be replaced by an inch system machine when the latter becomes available. Readings can be made to the equivalent of 0·00005 in., and by estimation to 0·00001 in., if necessary. A range of equipment supplied with the machine includes the 11·8-in. rotary optical table shown, and a variety of carbide-tipped measuring feelers for different applications

Jig-boring equipment installed in the factory includes this Société Genevoise Hydroptic 7A machine which is equipped with the DIR automatic co-ordinate repeating system, as described in MACHINERY, 95/427—9/9/59. This equipment enables up to 40 different co-ordinate settings, made on the machine in the course of normal working, to be recorded on two interchangeable memory drums, seen inside the glass-walled cabinet at the right. These settings can then be repeated automatically for the remaining components in a batch, or for subsequent operations on holes at a series of established centres. A chart giving the co-ordinates of each hole is supplied by the planning office

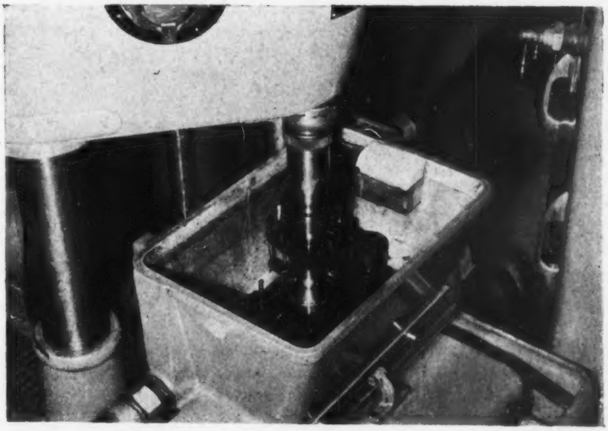


Jig-grinding operations are carried out on two Hauser machines, of which this type 5SM is the larger, and is here seen set up for grinding a drive head similar to that on the Trioptic measuring machine. Current for the grinding spindle motor is supplied by a frequency-changing unit at the rear of the machine, and it is driven at a speed of 19,000 r.p.m., for grinding a bore of 1·375 in. diameter. Other heads provide for various bore sizes, including diameters as small as 0·05 in., which are ground with a diamond wheel. The sensing unit on the table is connected to a small microphone pick-up which detects contact of the wheel with the work and varies the shape of the glow-discharge in a gas-filled tube

Horizontal boring and other operations are performed on this Kearns type 721P, Optimetric machine which has a spindle diameter of 4 in., and is here seen set up for boring a mild steel barrel housing plate. The two 9·75-in. diameter holes are held to ±0·0005 in., for both size and position, the latter being controlled by the built-in optical setting equipment. A casting waiting to be machined has been placed on the table in readiness for clamping after the barrel housing has been removed. Accuracy of longitudinal table movements on this machine is ensured by a long narrow guide and outboard support for the saddle is provided by rollers which run on flat surfaces on the bed extensions at front and rear



This Dean, Smith & Grace, 13 by 42 centre lathe is one of a battery of similar and larger machines and is fitted with hydraulic copying equipment whereby movements of the tool-holder at the rear of the cross-slide are controlled. Templates for use with hydraulic copying units, which are fitted to several of the lathes in the plant, are ground to the required form on Wickman optical profile grinding machines under pantograph control from drawings 50 times full size. With the set-up shown, a 2-part component for a mould for a plastics squeeze bottle is being turned. A similar mould part, on which turning operations have been completed, is seen resting on the board in the foreground



Two Wickman Erodomatic spark erosion machines are employed for the production of die and mould parts, also for making components of shapes which would otherwise be difficult to machine. The tool comprises a steel holder for a number of brass electrodes of tapered form, for the production of tapered slots in a plastics mould part. The machines are also employed for cutting internal helical fins in the bores of tools employed for correcting the alignment of cooling fins on nuclear reactor tubes. The tool employed for this work is equipped with a fixed sleeve having a helical slot which is engaged by a pin on the vertically-moving shaft carrying the electrode, so that the latter is turned as it is fed downwards

highly-skilled estimators, and are employed in the machine-loading forecasts. Records are kept of the estimated times, and they are subsequently compared, by means of the punched card equipment, with the actual times taken.

The weekly cost of running the factory, and the total weekly income, are shown by the punched cards, so that the management is constantly informed of the current financial position. For the system of cost control, some 80 steps are necessary to collate the information described and enable it to be made available at short notice.

Between the main building and the block mentioned, there is a rectangular standards room in which both temperature and relative humidity are closely controlled. This room contains a Société Genevoise Trioptic universal measuring machine, as described in MACHINERY, 99/1153—15/11/61, which is stated to be the only one of its type yet installed in this country. Illustrations on the following pages show this machine and certain others installed in the factory. The standards room is also provided with a Taylor, Taylor & Hobson, Talysurf surface-finish measuring instrument, and a Magna-Gage comparator with which readings can be obtained to 0·000005 in. by estimation. A third, 2-storey building, connected to the main block at the far, left-hand side, provides canteen and cloakroom facilities.

The company now employs some 160 skilled men in the various machining sections, and there are also 30 apprentices, who attend for one day per week at the local technical college. It is planned to provide for more comprehensive technical training for future apprentices who join the company.

New Elliott High-speed Centre Lathe

Following considerable development work and investigations into the requirements of lathe users in various countries, B. Elliott (Machinery), Ltd., Victoria Road, London, N.W.10, have introduced a new high-speed sliding, surfacing, and screw-cutting lathe, which incorporates a number of advanced design features. As may be seen in Fig. 1, the new lathe has a clean external appearance, and particular attention has been paid to ease of operation and maintenance. Flat surfaces fitted with rubber mats are provided on top of the headstock and tailstock on which tools and other items can be placed.

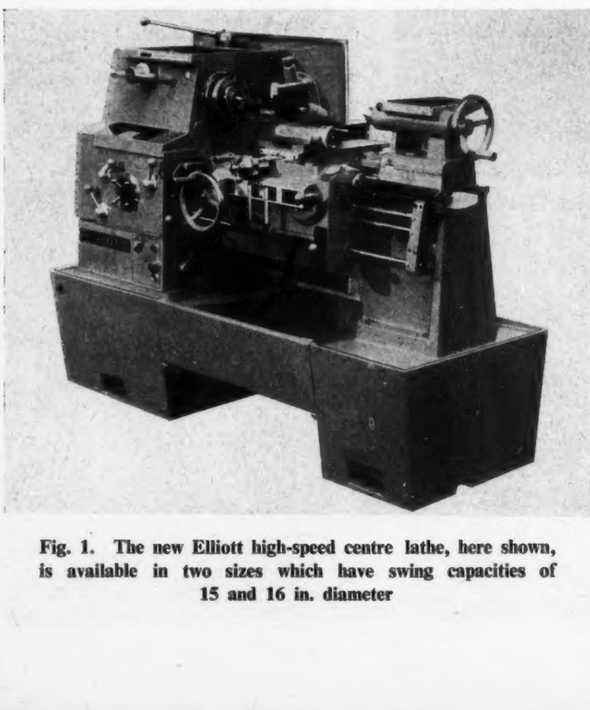


Fig. 1. The new Elliott high-speed centre lathe, here shown, is available in two sizes which have swing capacities of 15 and 16 in. diameter

The lathe is available in two sizes, designated M 15 and M 16, which will swing maximum diameters of 15 and 16 in. over the bed-ways, and 9½ and 10½ in. over the cross-slides. Both sizes can be supplied with different bed lengths which enable a maximum of 24, 36, 48, or 60 in. to be held between the centres. Of wide and deep cross-section, the gap-type bed—also other main structural components of the lathe—is cast in Acculite high-nickel iron, and may be supplied with flame-hardened guide-ways for the saddle if required. Fairly short components up to 20⅝ in. diameter can be swung in the gap on the smaller lathe, and up to 21⅝ in. diameter on the larger size. After removal of a short bed piece, work up to the maximum diameters mentioned can be swung in the gap for a maximum distance of 9⅜ in. from the face-plate. Substantial cast iron bases support the bed at the ends, and between them there is a chip tray

which can be readily withdrawn for cleaning.

Of patented design, the headstock incorporates an Omnispeed drive system which gives 12 spindle speeds in the range from 30 to 2,500, or from 20 to 1,650 r.p.m. If required, a 2-speed driving motor can be provided, and the 24 spindle speeds then obtainable range from 20 to 2,500 r.p.m. Drive may be taken from a motor of 4, 2½ or 2½/4 h.p., depending upon the spindle speed range, through V-belts to a first motion shaft, and thence to the spindle by way of gearing in the headstock for the eight lowest speeds in the range. For the higher speeds, a vibration-free drive between one of the shafts in the headstock and the spindle is transmitted by a timing belt. With this arrangement, the maximum peripheral speed of the driving gears is less than 700 ft. per min. even when the highest spindle speed in the range is engaged, and quiet running has thus been ensured. Four different speed ranges are selected by a lever on top of the headstock, and the individual spindle speeds in each range are engaged, as required, by a second lever on the front face. A pedal-operated spindle brake is fitted, which is applied to the pulley on the first motion shaft. Levers are provided at the headstock end of the bed and on the saddle for starting, stopping, and reversing the spindle drive. The lever on the saddle passes through a gate, and is moved in a direction towards the headstock, and then downwards, for reversing the spindle.

Angular contact bearings, or, alternatively, Gamet taper roller bearings, can be fitted at the nose end of the spindle. The headstock gears are lubricated by a built-in pump which serves also to deliver oil to a jacket for cooling the spindle bearings, and this arrangement is the subject of a patent application. Bored $2\frac{1}{16}$ in. diameter, the spindle will take a No. 3 Morse taper shank, and has a D.I.N. 6 flanged nose and a quick-acting swashplate locking arrangement to facilitate mounting chucks and turning fixtures. A hydraulically-operated collet chuck, which will take "dead length" collets up to 2 in. capacity, can be fitted.

The totally-enclosed quick-change feed gearbox enables a total of 45 Whitworth threads from 1⅛ to 80 per in., also 24 metric threads from 0·1875 to 10 mm. pitch to be cut without the need for change gears. In addition, a wide range of module and diametral pitches can be obtained from a single change of gearing. There is a total of 108 sliding and surfacing feeds, the former ranging from 0·0007 to 0·021 in., and the latter from 0·0005 to 0·015 in. per rev. An arrangement is incorporated in the drive which causes the feeds to be automatically reduced in the ratio of 4 to 1 when any of the four highest spindle speeds in the range are engaged. In this way, operation of the feed gears at excessively high speeds is prevented, and a range of fine feeds for high-speed turning operations is provided. The feed gears are so arranged that coarse changes are made by a pair of levers mounted on the front of the gearbox, and fine changes by a central capstan-type handwheel fitted with a dial. A third lever on the gearbox provides for reversing and engaging and disengaging the leadscrew drive. Provision is made for reversing the leadscrew end-for-end when it has become worn over part of its length. There is a built-in pump for lubricating the feed gears.

Of double-wall construction, the apron incorporates two patented snap-action levers, which operate V-toothed clutches for engaging and dis-

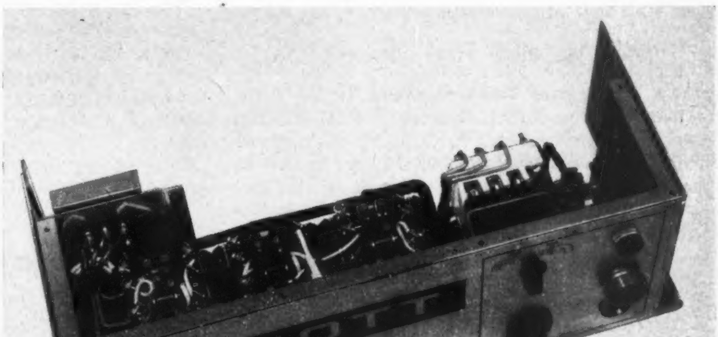


Fig. 2. The unit which houses the electrical equipment on the new Elliott centre lathe can be removed from the machine as a single assembly for maintenance purposes

engaging the sliding and surfacing feeds, and are interlocked with another lever for bringing the half-nuts into and out of engagement with the leadscrew. The apron gears run in an oil bath. A micrometer stop unit can be supplied for controlling the sliding movement, and a nylon safety clutch is then fitted in place of the shear pin normally provided. The latter, which is housed in a plastics cover, is mounted on the front of the apron and can be quickly replaced when necessary. The swivel top slide can be fitted with a 4-way toolpost arranged for ratchet indexing, or a quick-change tool-holder, and the traversing screw for the cross-slide forms part of a telescopic arrangement which can be readily connected to a taper turning attachment. If required, hydraulic copying equipment can be provided.

The tailstock body can be set over on the base for taper turning, and the 2¼-in. diameter barrel, which is bored No. 3 Morse taper, has a travel of 4¾ in.

Electrical equipment, which incorporates no-volt release, mechanically-interlocked reversing contactors, and overload protection arrangements, is housed in a unit mounted below the feed gearbox. After two fixing bolts have been removed, and a linkage has been disconnected from the lever for controlling the spindle drive, this unit can be withdrawn from the machine as a single assembly for maintenance purposes. A view of the unit is given in Fig. 2.

Gauge and Tool Makers

At a luncheon of The Gauge and Tool Makers' Association, Standbrook House, 2-5 Old Bond Street, W.1, which was held at the Connaught Rooms, London, on December 12, certificates of craftsmanship and of gauge and tool design and draughtsmanship were presented to apprentices to whom they had been awarded during the preceding 12 months. Also, the prizes were presented to the successful competitors in the 1961 competition in craftsmanship and draughtsmanship organized by the Association.

The presentations were made by the president, Sir Stanley J. Harley, B.Sc., M.I.Mech.E., M.I.Prod.E., who was in the chair, and by the principal guest, The Rt. Hon. Lord Chandos, P.C., D.S.O., M.C., chairman of Associated Electrical Industries, Ltd. Sir Stanley offered a special welcome to Lord Chandos and expressed the gratitude of the Association for the great assistance that had been rendered by A.E.I. (Rugby), Ltd., in connection with the competition. They had taken delivery of all the entries which had then been passed to the very competent inspection department, and a report on the dimensional accuracy and finish of each item had been prepared. These reports had been made available to the adjudicating panel, who had thus been greatly assisted in their exacting task.

Sir Stanley went on to express thanks to Prof. John Loxham, C.G.I.A., M.I.Mech.E., M.I.Prod.E., M.B.I.M., for the facilities that were being afforded to the Education Committee of the Association by The College of Aeronautics, Cranfield.

There had been a record number of entries for this year's competition and it appeared that the standard was the highest yet attained. Member firms which had accorded facilities to apprentices to enter were to be commended, and there was no doubt that both apprentices and firms would benefit.

Speaking of the Education Trust that had been formed, Sir Stanley mentioned that the target was a capital sum of £25,000 for the provision of scholarships and similar purposes. An amount approaching half this total was already available, and he made a special appeal to those who had not already contributed to this important project. Awards had already been made to four of the prize winners in this year's competition (D. Bagley, L. J. Barrett, L. Bradbury, R. G. Hyde) which would enable them to visit precision engineering works in Switzerland next year.

Lord Chandos emphasized that, despite opinions sometimes expressed to the contrary, the importance of craftsmanship had not diminished, although some of the fields of application had changed. In the metal working industries it was necessary to work to increasingly close tolerances and the gauge and tool maker was the keystone to modern production. The younger generation, he continued, was often criticized—but never by him. "If you criticize the young, you criticize the future."

Trade Publications

THE PYRENE CO., LTD., Metal Finishing Division, Great West Road, Brentford, Middlesex. Folder giving particulars of the spray gun Bonderizing process for the treatment of large or awkwardly shaped components which cannot be processed in normal Bonderizing plants.

ENGLISH STEEL CORPORATION, LTD., River Don Works, Sheffield, 9. Revised and enlarged edition of the company's useful booklet on the care and use of E.S.C. engineers' cutting tools. Sections are devoted to the Easicut "blue" drill, taps, reamers, milling cutters, tool bits, and various tables are included giving, for example, surface speeds for different diameters and r.p.m., a comparison of hardness numbers, functions of numbers, and tapers and angles.

NEWS OF THE INDUSTRY

The Midlands

P.M.T. (Machine Tools), Ltd., Oozells Street, Birmingham, report a steady increase in the sales of machine tools for which they are sole agents in the United Kingdom. In this connection we are informed that the Italian-built Manex jig boring machine is in growing demand from firms engaged in contract jig and tool production.

This machine is equipped with optical scales, arranged for direct reading to 0·001 in. and 0·0001 in., for the longitudinal and transverse table movements. Steplessly-variable spindle speeds from 50 to 1,800 r.p.m. and three feeds, of 0·0015 in., 0·003 in. and 0·006 in. per rev., are provided. All gears are hardened and ground, and the castings are of Meehanite metal. Reciprocating motion can be applied to the 12-in. by 24-in. work-table at speeds of 20 in. and 40 in. per min. for precision grinding operations.

S.A.I.M.P. milling machines and centre lathes, and Famir universal grinding machines, which are all of Italian make, are also attracting interest.

C. & L. Industries (Birmingham), Ltd., Station Road, Birmingham, 23, are still very busy on a wide variety of contract machining, and are well placed for other work including the production of jigs and fixtures. Facilities are available for jig boring and jig grinding.

Chaphone Engineering Developments, Ltd., Reddicap Industrial Estate, Sutton Coldfield, Warwicks., inform us that increasing interest is being shown by firms in the United Kingdom in Chaphone vertical and horizontal honing machines, and that enquiries have also been received from the Far East, India, Israel, Italy, Western Germany and the U.S.A. The types C.V.3 and C.V.5 vertical honing machines can be arranged to provide an automatic 2-stage roughing and finishing cycle, as required for operations in the bores of hydraulic cylinders made from cold drawn steel tubes. Roughing and finishing honing stages are controlled automatically by timers, but the spindle speed and reciprocating speed are varied during the second stage by the machine operator. In one company, where five of these machines are installed for honing hydraulic cylinders, it is stated that the size and finish of the bores is maintained consistently despite the fact that the operators change frequently as a result of shift work.

A number of Chaphone horizontal honing machines is being built, and the largest machines of this type are designed to finish bores up to 35 ft. long by 14 in. diameter. High rates of stock removal are claimed for these machines, and provision is made for short-stroking over any part of the bore being honed. Honing stones for a wide variety of applications can be supplied and advice can be given on honing problems.

Midland Designing & Manufacturing Co., Ltd., Heath Mill Road, Wombourn, Staffs., are as busy as ever with the construction of jigs, fixtures, and prototype equipment for the aircraft and other industries, and report increasing demands on the contract drawing and designing services. The works have an area of 5,000 sq. ft. on one floor and space is available for extension when required. Among the machine tools installed we may note two Webster & Bennett 48-in. vertical boring and turning mills, an 8-ft. by 4-ft. Stirk planing machine, two Herbert 9B capstan lathes, and a Jones & Shipman 540 horizontal surface grinder.

Gittings & Mellor, Ltd., Heath Mill Road, Wombourn, Staffs., are now well established in new works to which their manufacturing plant was recently transferred. Orders are in hand for a wide variety of weld fabricated handrails, stairways, and other steelwork, including heavy balustrading for the new motorways now under construction in this country. A good call is reported for the company's Liteway open-work steel flooring for boiler houses, processing installations, and factories. The construction of fabricated grids for mounting above hoppers in steelworks, and knock-out pits in foundries, is frequently undertaken by this firm.

F. W. Herridge.

Mortimer Machine Tool Exhibition

Mortimer Machine Tool Co., Ltd., recently held an exhibition of machine tools for which they are selling agents at their showrooms in Mortimer House, Acton Lane, London, N.W.10. These showrooms, it may be mentioned, have now been extended to provide an area of more than 5,000

sq. ft. The exhibits included a range of Koping lathes and milling machines, the lathes embracing the type S8C heavy duty machine with hydraulic copying equipment, the type S8S machine and the type S8SG gap bed lathe. An interesting feature of the latter machine is the hinged gap piece, which is swung to the rear of the bed, but is not removed, and there is a third guideway at the front of the bed to provide support for the saddle when the gap is being used.

A new Koping vertical milling machine—the type VF 10—was demonstrated, and has power feed to the quill, at any angle up to 45 deg. on either side of the vertical. Feed rates are steplessly variable from ¾ to 20 in. per min., ⅜ to 10 in. per min., or from $\frac{3}{16}$ to 20 in. per min. The feed drive is from a ½-h.p., d.c. motor, through a worm and wheel. A maximum travel of 4 in. is provided and there are adjustable stops to terminate the feed motion in both directions of travel. A larger VF 20 milling machine, with power feed to the quill, was also shown.

Fromag keyseating machines on view included the type KZ.32 mechanical unit and a new type KZ.22 hydraulic machine. Reference to the latter unit will be made later in MACHINERY.

The company are now agents for the American-built Grob bandsawing and bandfiling machines, and representative examples of each type were shown. Both machines will be described in a subsequent article.

Among other exhibits may be mentioned the Maho type MH.800 universal tool milling and die-sinking machine, Abene type VHF/2B and VHF/3 combined vertical and horizontal milling machines, the Reichle & Knoedler TFV vertical spindle surface grinder, and type SJ 16 and SJ 12 hydraulic horizontal spindle surface grinders built by Svend Jakobsens Maskinfabrik, Denmark.

The Possibilities of Hot Machining

(*Continued from page* 1467)

possible here to discuss the advantages and disadvantages of all these methods, but it is pointed out by the authors of the paper that induction heating is most commonly employed in spite of the comparatively high initial expense. With the object of overcoming certain limitations of other heating systems, the possibilities of passing radio-frequency current through the work material have been investigated with promising results. This technique, it may be recalled is being employed very successfully for certain welding operations, and when it is applied to work heating, the path of the current can be effectively controlled. Thus, for a turning operation, the current can be directed, between electrodes, through a surface layer extending round part of the periphery, to heat the material before it reaches the tool.

It seems probable that hot machining will be extensively employed in the future to facilitate operations on the refractory metals and alloys, and as more practical experience of its advantages is gained, the field of application may well be extended to cover certain other materials which, although they do not present the same difficulties, nevertheless impose severe conditions on cutting tools.

Churchill Machine Tool Sales

It is announced by B.S.A. Tools Group, Ltd., that from January 1, 1962, the United Kingdom sales representation for The Churchill Machine Tool Co., Ltd., Broadheath, Manchester, will be in the hands of Burton Griffiths & Co., Ltd., Mackadown Lane, Kitts Green, Birmingham, 33.

Aeronautical College Prizegiving

At the recent annual prizegiving ceremony of the College of Aeronautical and Automobile Engineering, Sydney Street, London, S.W.3, the awards were presented by Sir Matthew Slattery, K.B.E., C.B., D.Sc., F.R.Ae.S., who is president for the current year.

Addressing the guests before the presentations were made, the principal, Mr. J. A. C. Williams, said that nearly half of the total passes which had been awarded in the City and Guilds Motor Vehicles Electricians' examination this year had been won by students of the College, including four of the five 1st-class passes. Some students had achieved the previously unique distinction of qualifying for two City and Guilds technological certificates—in both automobile and agricultural engineering. The work of the College had been extended by the establishment of metrology and electronics departments, and further equipment for instructional purposes was being acquired. Although the College had been assisted in this respect by certain friends in industry, Mr. Williams continued, the positive help that they would like to have received, from the industries to the future welfare of which the College was contributing so much, had not been forthcoming.

New Appointments

The following new appointments have been announced:—

MR. JENNER R. THOMAS, as general manager of Fletcher, Brock & Collis, Ltd., Fowler Road, Hainault, Essex. He was formerly with The Plessey Co., Ltd., and a director of Amar Tool & Gauge Co., Ltd., and joined the firm early in 1961 as consultant engineer to the board.

MR. W. ATKINSON ADAM, M.I.Mech.E., as managing director of the three British divisions of The Yale & Towne Manufacturing Co. He succeeds MR. JOHN T. MCCARLEY, who has been appointed director of manufacturing of the international operations of Yale & Towne, with headquarters in New York.

Industrial Notes

CLARKSON (ENGINEERS), LTD., Nuneaton, are opening a sales training college for the instruction of representatives on joining the company. There will also be refresher courses from time to time for members of the sales force.

INDUSTRIAL EDUCATION INTERNATIONAL, LTD., 66 Chandos Place, Strand, London, W.C.2, have arranged for a series of one-day seminars concerned with: evaluating the individual future job performance, and determining manpower capabilities in an organization. These seminars, which will be conducted by Dr. A. T. Polin, associate professor of management at the University of Southern California, will be held in Birmingham, Manchester, and London, in January. Full particulars can be obtained from the above address.

THE PURCHASING OFFICERS ASSOCIATION, Wardrobe Court, 146a Queen Victoria Street, London, E.C.4, have arranged for a course on "Computers in Purchasing and Stores Departments," to be held at the College of Aeronautics, Cranfield, from January 8 to 11. The leader of the course will be Mr. J. W. Wright, M.A., Lecturer in Industrial Administration, Manchester College of Science and Technology, Manchester University. Full particulars can be obtained from the Education Officer of the Association.

Scrap Metals

MIDLANDS.—Processed heavy scrap is still difficult to place except against the limited allocations for local steelworks. Deliveries of grades No. 1 and 2, No. 3 medium scrap, No. 4 new steel bales; and No. 6 light iron are all completed early in each week, and surplus tonnages are held in stock at merchants' yards.

Demand for short heavy steel scrap is very restricted, and lower grades of scrap and shovelling material can only be loaded for steelworks when markets are available. Limited tonnages of 0·04 quality short heavy steel are being moved locally but prices have fallen for new orders covering 1962 deliveries.

Cast iron scrap has been in strong demand for many months and the position has now become somewhat easier, as foundries are building up stocks and can obtain further supplies at short notice. There is still a scarcity of cylinder quality cast iron and interest is shown in complete engines for stripping.

Blast furnace materials such as turnings, borings, and bales are being moved steadily within the allocation limits but there are no indications of increased supplies being required, and prices have been reduced for new orders.

Export of scrap of the permitted grades is proceeding steadily but prices are not particularly attractive and merchants are hoping for some improvement in the home markets early next year.

Completion of "scrap" tenders for 1962 covering production at works confronts merchants with many problems. It appears that offers will be lower as compared with last year, and that clauses will be inserted to cover increases or decreases according to market trends.

Coming Events

Institution of Mechanical Engineers. *Eastern Branch.* January 4, at 7.30 p.m., at The Sun Hotel, Hitchin; lecture on "Powder Metallurgy Applications," by B. H. Swan. *Midland Branch.* January 4, at 6 p.m., at the James Watt Memorial Institute, Great Charles Street, Birmingham; lecture on "Machine Tool Research, Design and Utilization," by Dr. D. F. Galloway.

The Institute of Metal Finishing. *Midland Branch.* January 2, at 6.30 p.m., at the James Watt Memorial Institute, Great Charles Street, Birmingham; discussion on "Stripping and Reclamation of Defective Plated Work," by T. E. Such.

Institution of Production Engineers. *Wolverhampton Section.* January 3, at 7.15 p.m., at The Wolverhampton and Staffs. College of Technology, Wolverhampton; lecture on "Recent Developments in Automatic and Semi-Automatic Welding," by L. H. Morgan. *Doncaster Section.* January 9, at 7 p.m., at the Technical College, Waterdale, Doncaster; lecture on "British Standards," by Dr. H. M. Glass, Deputy Technical Director, B.S.I.

Machine Tool Share Market

After displaying dullness and uncertainty, stock markets developed a good tone in the principal sections, and finished the period under review on a firm note.

The gilt-edged market held steady, and, on balance, gains were recorded among British Funds and similar fixed-interest stocks. Commercial and industrial markets became fairly active and cheerful after early quietness. Although buying interest remained selective, and movements among prices were generally small and irregular, the trend, in the main, was towards the higher price levels, and many bright features have been in evidence.

Among machine tool issues, British Oxygen advanced 2s. to 16s. 6d.; Newall Engineering, 6d. to 7s. 6d.; and John Shaw & Sons (Wolverhampton), 3d. to 14s. 1½d. On the other hand, Edgar Allen lost 9d. at 29s. 3d.; Broom & Wade, 1s. at 21s.; Clarkson Engineers, 3d. at 7s.; Craven Bros. (Manchester), 1½d. at 8s.; John Holroyd "B," 1s. at 16s. 9d.; Kerry's (Gt. Britain), 3d. at 7s. 6d.; Sheffield Twist Drill, 9d. at 21s.; Stedall & Co., 3d. at 7s. 3d.; and Thos. W. Ward, 5s. at 57s. 6d.

COMPANY		Denom.	Middle Price
Abwood Machine Tools, Ltd.	Ord.	1/-	1/6
Allen (Edgar) & Co., Ltd.	Ord.	£1	29/3
,, ,, ,,	5% Prf.	£1	12/9
Arnott & Harrison, Ltd.	Ord.	4/-	12/-
Asquith Machine Tool Corp., Ltd.	Ord.	5/-	10/-
,, ,, ,,	6% Cum. Prf.	£1	16/6
Birmingham Small Arms Co., Ltd.	Ord.	10/-	19/-
,, ,, ,,	5% Cum. "A" Prf.	£1	13/-
,, ,,	6% Cum. "B" Prf.	£1	16/6
,, ,,	4% 1st Mort. Deb.	Stk.	90½
British Oxygen Co., Ltd.	Ord.	5/-	16/6
,, ,, ,,	6% Cum. Prf.	£1	18/-
Brooke Tool Manufacturing Co., Ltd.	Ord.	5/-	7/7½
Broom & Wade, Ltd.	Ord.	5/-	21/-
,, ,,	6% Cum. Prf.	£1	16/-
Brown (David) Corporation, Ltd.	5½% Cum. Prf.	£1	14/-
Buck & Hickman, Ltd.	6% Cum. Prf.	£1	15/6xd
Butler Machine Tool Co., Ltd.	Ord.	5/-	15/-
,, ,, ,, ,,	5% Cum. Prf.	£1	12/1½xd
Churchill (Charles) & Co., Ltd.	Ord.	2/-	8/4½
,, ,, ,,	6% Cum. Prf.	£1	25/7½‡
Clarkson (Engrs.), Ltd.	Ord.	1/-	7/-
Cohen (George), 600 Group, Ltd.	Ord.	5/-	9/6
,, ,, ,,	4½% Cum. Prf.	£1	12/-
Coventry Gauge & Tool Co., Ltd.	Ord.	10/-	30/10½
,, ,, ,,	5% Cum. Red. Prf.	£1	16/3
Craven Bros. (Manchester), Ltd.	Ord.	5/-	8/-
Elliott (B.) & Co., Ltd.	Ord.	1/-	2/9
,, ,,	4½% Red. Cum. Prf.	£1	11/3
Firth Brown Tools, Ltd.	4% Cum. Prf.	£1	10/6
Greenwood & Batley, Ltd.	Ord.	10/-	15/6
Harper (John) & Co., Ltd.	Ord.	5/-	7/9
,, ,, ,,	4½% Red. Cum. Pref.	£1	9/6

COMPANY		Denom.	Middle Price
Herbert (Alfred), Ltd.	Ord.	£1	62/6
Holroyd (John) & Co., Ltd.	"A" Ord.	5/-	20/-
,, ,,	"B" Ord.	5/-	16/9
Jones (A. A.) & Shipman, Ltd.	Ord.	5/-	25/-
,, ,, ,,	7% Cum. Prf.	5/-	4/3
Kearney & Trecker-C.V.A., Ltd.	5½% Red. Cum. Prf.	£1	8/9xd
,, ,, ,,	Prefd. Ord.	£1	13/9xd
Kearns (H. W.) & Co., Ltd.	Ord.	5/-	19/9
Kerry's (Gt. Britain), Ltd.	Ord.	5/-	7/6
Macreadys Metal Co., Ltd.	Ord.	5/-	15/-
Martin Bros. (Machinery), Ltd.	Ord.	2/-	2/6
Massey (B. & S.), Ltd.	Ord.	5/-	11/-
Newall Engineering Co., Ltd.	Ord.	2/-	7/6
Newman Industries, Ltd.	Ord.	2/-	7/-
,, ,,	6% Prf. Ord.	5/-	5/-
Noble & Lund, Ltd.	Ord.	2/-	5/6
Norton, W. E. (Holdings), Ltd.	Ord.	2/-	9/6
Osborn (Samuel) & Co., Ltd.	Ord.	5/-	53/-
,, ,, ,, ,,	5½% Cum. Prf.	£1	22/-
Pratt (F.) Engineering Corporation, Ltd.	Ord.	5/-	15/6
Sanderson Kayser, Ltd.	Ord.	10/-	34/3
,, ,,	6½% Cum. Prf.	£1	16/3xd
Scottish Machine Tool Corporation, Ltd.	Ord.	4/-	7/9
Shardlow (Ambrose) & Co., Ltd.	Ord.	£1	51/3xd
Shaw (John) & Sons, Wolverhampton, Ltd.	Ord.	5/-	14/1½
Sheffield Twist Drill & Steel Co., Ltd.	Ord.	4/-	21/-
,, ,, ,,	5% Cum. Prf.	£1	13/3
Stedall & Co., Ltd.	Ord.	5/-	7/3
Sykes (W. E.), Ltd.	"B" non-voting Ord.	10/-	24/4½
Tap & Die Corporation, Ltd.	Ord.	5/-	18/-
,, ,, ,,	4½% Deb. 1961-1977	Stk.	81½
Wadkin, Ltd.	Ord.	10/-	26/-
Ward (Thos W.), Ltd.	Ord.	£1	57/6
,, ,,	5% Cum. 1st Pref.	£1	13/6xd
,, ,,	5% Cum. 2nd Pref.	£1	20/-xd
Willson Lathes, Ltd.	Ord.	1/-	2/6

The Middle Prices given in the list are in several cases nominal prices only and not actual dealing prices. Every effort is made to ensure accuracy, but no liability can be accepted for any error. * Sheffield price. ‡ Birmingham price.

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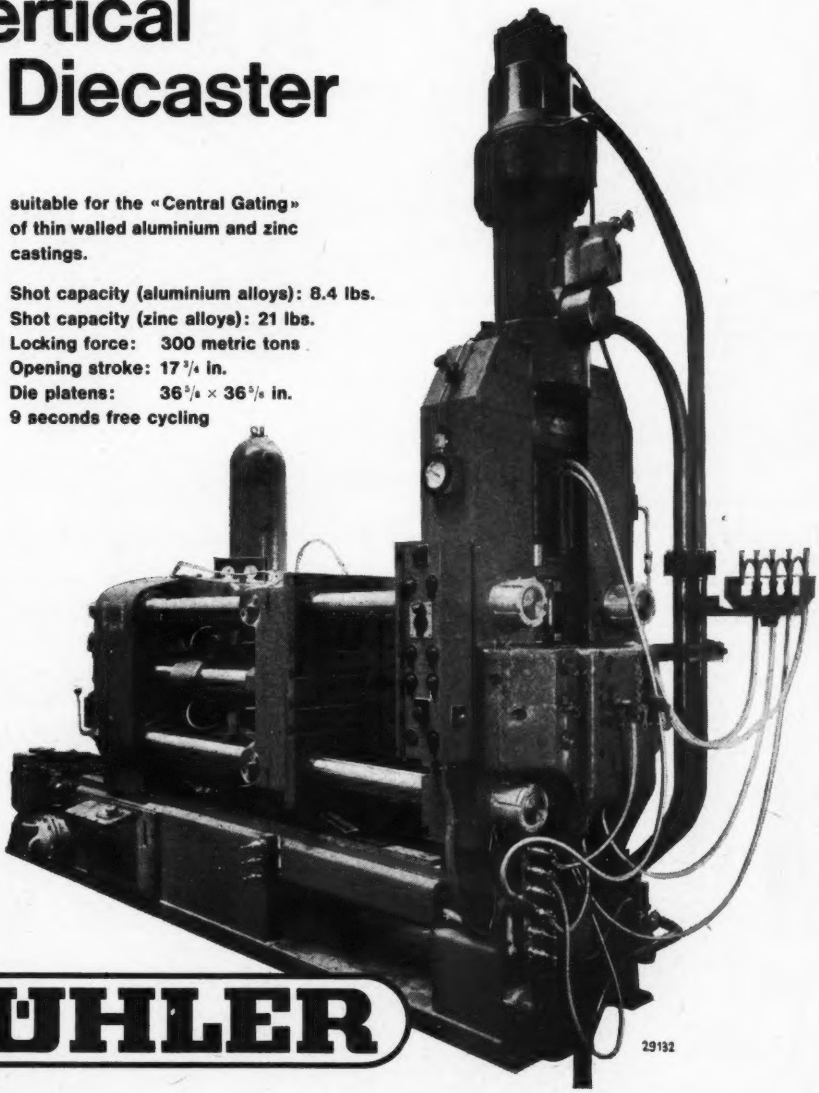
9 seconds free cycling



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Alum lbs. ...	—	1¼	2·1	4·5	—
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Platen stroke	4½	6	8	11	13

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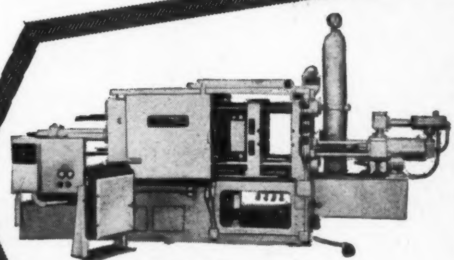
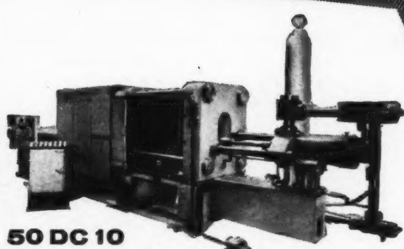


40 DC 5
Locking force: 300 tons
Shot weight: 5½ lb. aluminium 15 lb. brass



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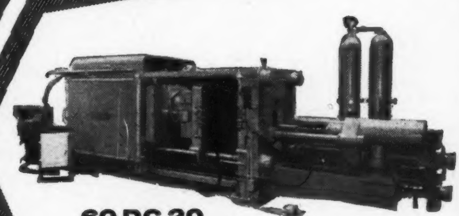

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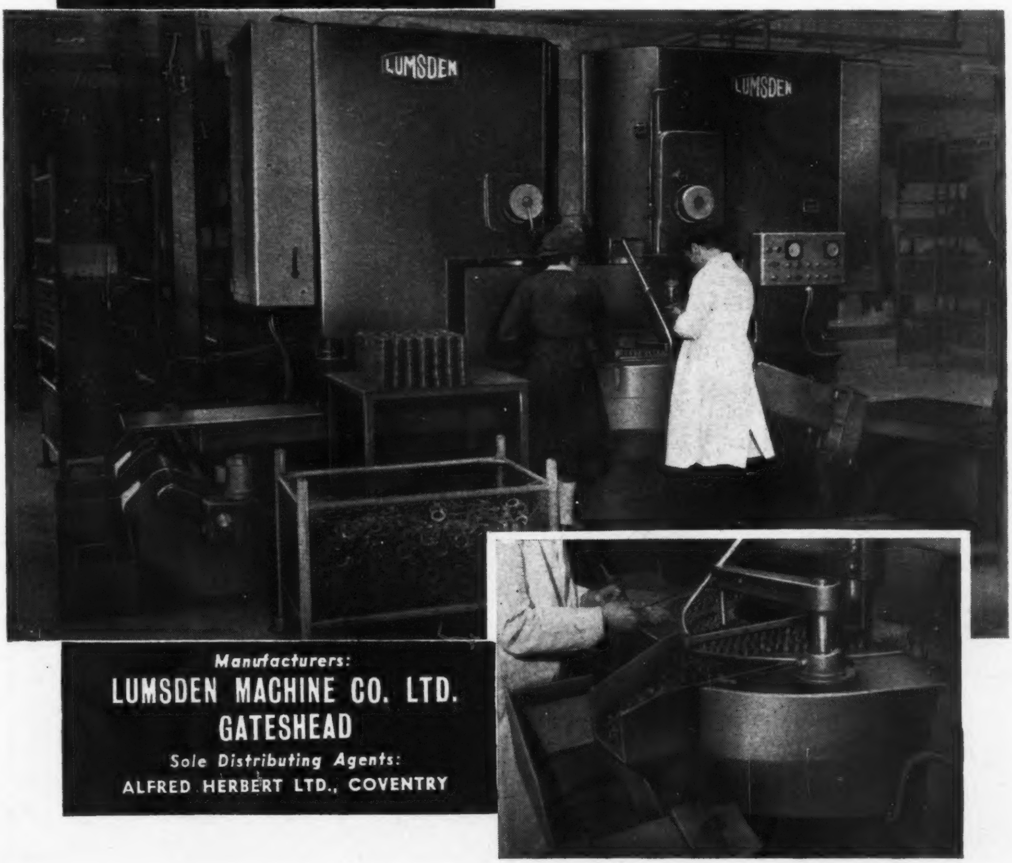

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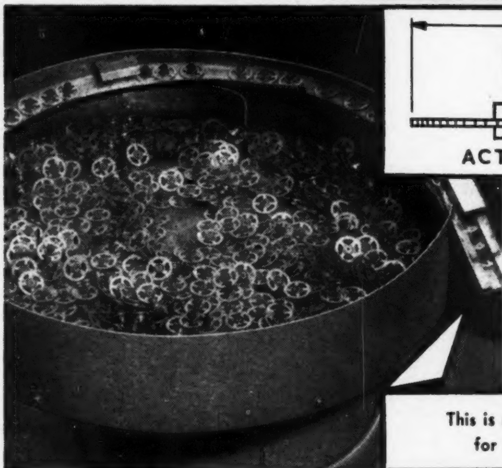

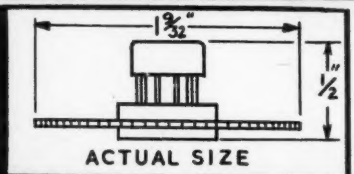

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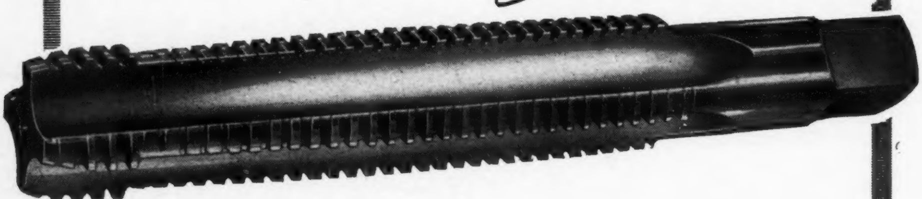

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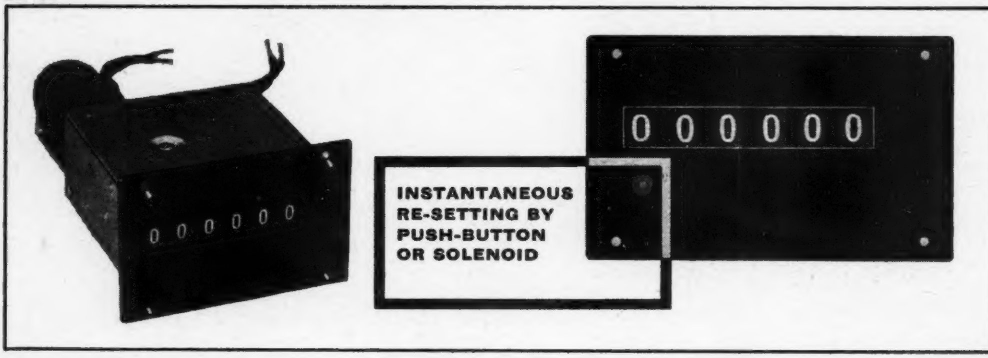

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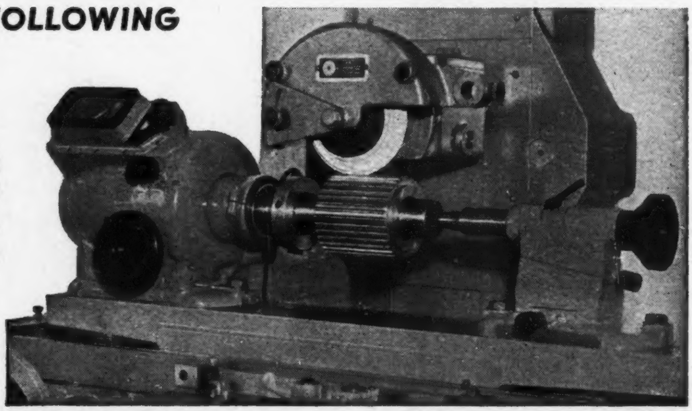

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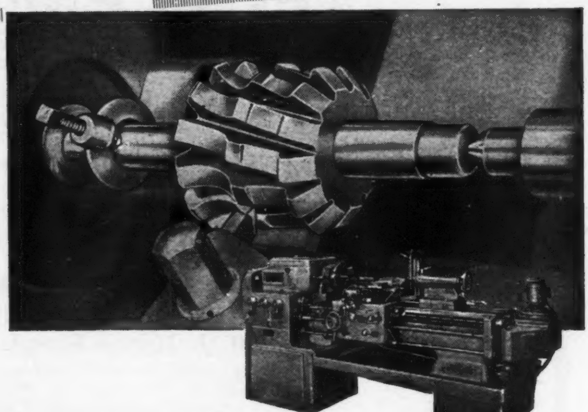

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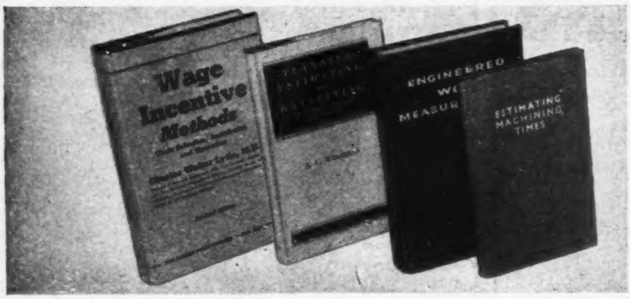

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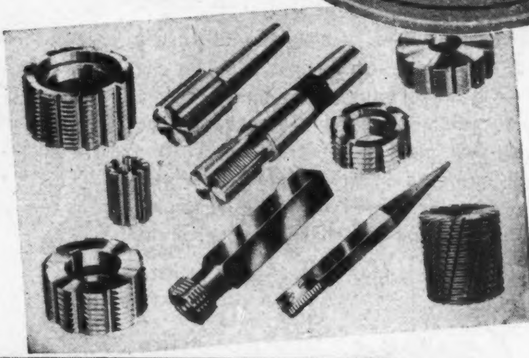

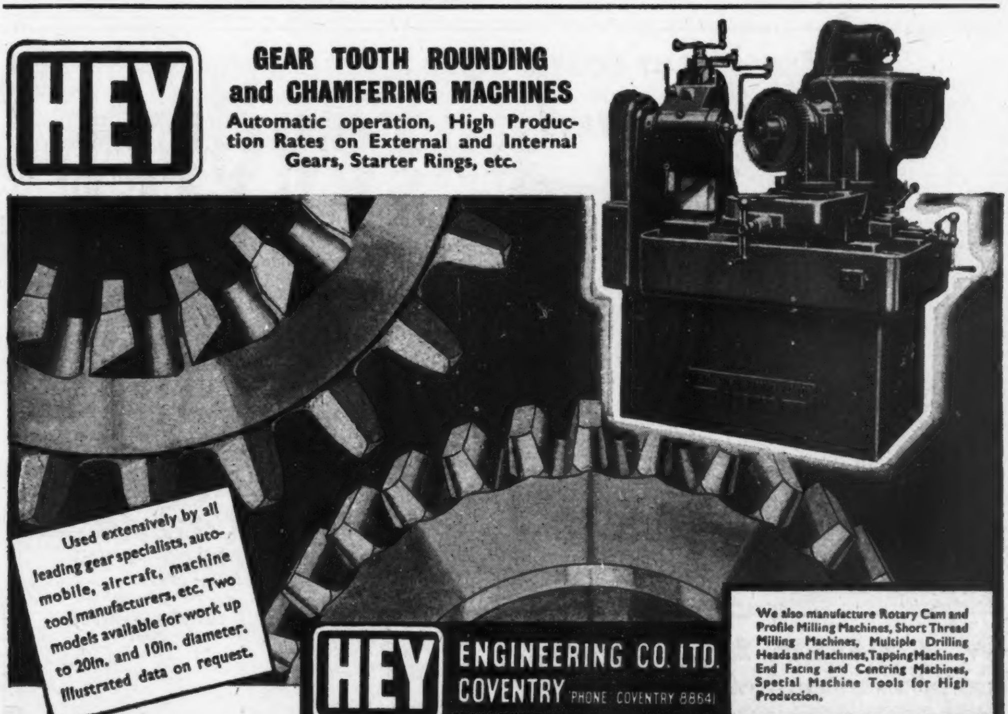
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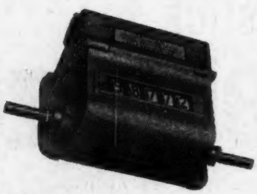

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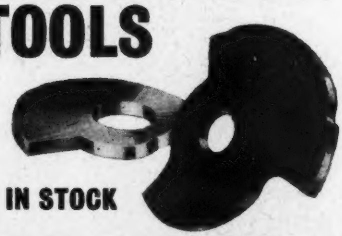

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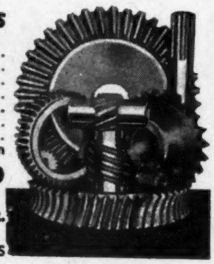

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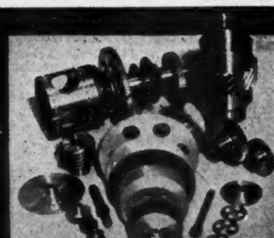

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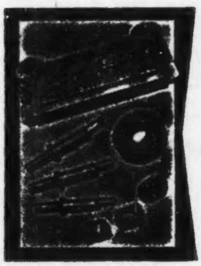

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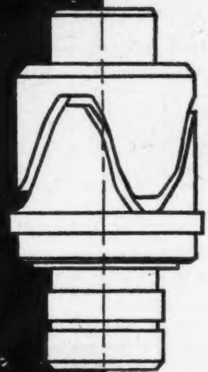

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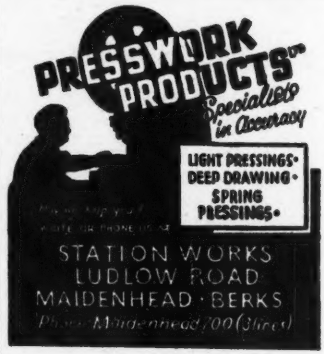

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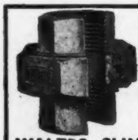

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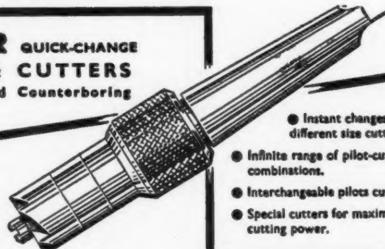

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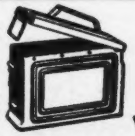

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CRAVEN 36in. heavy duty, side head, elevating cross rail, rapid feeds.

GRINDERS

LANDIS 6in. × 18in. Hyd. Plain Cylindrical P.F. (1952).
MYFORD 5in. × 9in. Model MG9 Plain Cylindrical. Rebuilt.
FITCHBURG 12in. × 32in. Universal.
HEALD 72A3 Internal Grinders, Series 18,000. (Choice of two.)
HEALD 72A5 Internal Grinders, Series 18,000. (Choice of two.)
LUMSDEN 24in. dia. Retractable Rotary Table Surface Model 90RT. With Chuck (1952).
FITCHBURG 48in. Spline.
ORCUTT 20in. Spline.

GEAR MACHINERY

GLEASON No. 24 Straight Bevel Generator S/N17920.
FELLOWES No. 75A High Speed Gear Shaper for Spur and Helical Gears. (Choice of two.) S/Ns 24836 and 18965.
FELLOWES 615A Gear Shaper S/N21074.
MICHIGAN Gear Lapper. S/N2280.
BARBER & COLMAN No. 2 Gear Hobber. S/N 5753-110.

DRILLS

Radial
ARCHDALE 4ft. 0in.; 60 to 1,500 r.p.m. (Choice of four.)
KITCHEN & WADE 4ft. 0in. Bridge Type.

Single Spindle
ASQUITH Type U.G.D. 3in. Cap.; 31/850 r.p.m. Column. (Choice of two.) 1952.
POLLARD CORONA $\frac{5}{16}$in. Cap. 642-12,040 r.p.m. bench. (Selection of several.)

Multi Spindle
BARNESDRILL Hyd. Type H.4 16 Sp. ⅝in. Cap.
ARCHDALE Cluster 12 Sp. ⅝in. Cap.
POLLARD Corona Model H.E.F., 4 Spindle, $\frac{5}{16}$in. Cap. 642-12,040 r.p.m. Bench. (Choice of two.)

MILLING MACHINES

Plano
KENDALL & GENT, table 5ft. × 4ft. × 4ft. 6in.

Vertical
HERBERT 28V, table 85in. × 28in.; 12 to 360 r.p.m.
HERBERT 47. Table 72in. × 17in.; 21 to 750 r.p.m.
CINCINNATI 4 VHP, table 78½in. × 16½in.; 17 to 480 r.p.m.
CINCINNATI No. 4 Dial type, table 78½in. × 16½in., 18 to 450 r.p.m. Power down feed.
CINCINNATI No. 3 Dial Type, table 62½in. × 15½in.; 18 to 450 r.p.m. (Choice of three.)
CINCINNATI No. 2 Dial type, table 52½in. × 12½in.; 20 to 500 r.p.m.
ARCHDALE 18in., table 38in. × 10in.; 79 to 2,000 r.p.m.

Plain Horizontal
ARCHDALE 20in., table 40in. × 10in.; 60 to 1,230 r.p.m. Rapid Production.
CINCINNATI 2/24 Production.
CINCINNATI O8, table 18½in. × 6½in.; 75 to 1,100 r.p.m. Production. (Choice of two.)

LATHES

Centre
SWIFT 13in. × 132in.; 3.6 to 220 r.p.m. Straight Bed.
SPRINGFIELD 12in. × 48in.; 9 to 380 r.p.m. Straight Bed.
SCULFORT 12in. × 70in.; 12.5 to 1,000 r.p.m. 1952.
DEAN, SMITH & GRACE 12in. × 66in., 19 to 418 r.p.m. Straight Bed.
PROGRESSIVE 11in. × 120in.; 20 to 516 r.p.m. Gap Bed.
SWIFT 10½in. × 96in.; 11 to 400 r.p.m. Straight Bed.
DEAN, SMITH & GRACE 8½in. × 50in.; 11 to 490 r.p.m. Straight Bed.
HOLBROOK 8½in. × 48in. Speeds 7.5 to 400 r.p.m. Straight Bed. (Choice of two.)
PROGRESS 8in. × 60in.; 23 to 1,050 r.p.m. Gap Bed.
DEAN SMITH & GRACE 8in. × 30in.; 11-490 r.p.m. Straight Bed.
HOLBROOK 6½in. × 40in. Speeds 15 to 400 r.p.m. S.S. & S.C. Straight Bed.

Capstan, Comb. Turret
LIBBY IH5 Comb. Hole in spindle 5½in. Power and rapid feeds to Saddle, Turret and Cross slide.
GISHOLT 2L Comb. 22in. swing. 1952 built.
HERBERT 21 Comb. No cross slide.
WARD 10B Comb. Power feed to Turret, Air Ball Chuck, Bar Feed Equipment Rebuilt.

VARIOUS

BARNESDRILL 5in. × 25in., Vertical Honer.
RHODES 75 ton Double Sided Single Geared Press, fitted with Worsam air cushion.
BUTLER 24in. Heavy Duty Production Type Slotter.
BUTLER 12in. Stroke Slotter with tilting table.
BUTLER 18in. Stroke Super Shaping Machine.

NEW—FROM STOCK

BRONX PRESS BRAKES

Series 98, 90/135 tons, 8ft. × $\frac{5}{16}$in.
Series 68, 60/90 tons, 8ft. by 10G
Series 48, 40/60 tons, 8ft. by 14G

OTHER NEW MACHINES

BINNS & BERRY 12½in. × 90in. S.S. & S.C. Gap Bed Lathe, speeds (16) 12-600 r.p.m.
HEINEMANN 28in. Stroke, Heavy-duty, High-Speed, Hydraulic Shaper with power down feed.
DENBIGH D.4 Mill, Table 46in. × 10in.; 22-720 r.p.m.

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MACHINES NOW IN STOCK

TATE

AUTOMATIC

RYDERMATIC No. 18 Vertical Automatics 60 H.P.

BORING MACHINES

MATHEYS Model FPN/28 Semi Jig Borer. (1956.)
PADDON Mk. 3 type WP Cylinder Re-Boring Machines.

HONING AND LAPPING

DELAPENA Honing Machine.
KITCHEN & WADE Hydraulic Vertical Honing Machine.

CAPSTANS & TURRET LATHES

WARD 2A Bar Feed, Ball chuck and tooling.
AG-UR 2in. Capacity Capstans. Full equipment (New).
BOLEY-LEINEN Model ER15 ¾in. Capstan (Modern) (1953).
GISHOLT No. 3 Capstan Lathe.
HERBERT Model 22A Turret Lathe. 8½in. Spindle Hole.
TIMBRELL & WRIGHT Turret Facing Lathe, 6in. Hollow Spindle.

CENTRE LATHES

WILLSON 7½in. Newel Lathe.
SOUTHBEND 7in. Centre Lathe.
CRAVEN Heavy Duty Railway Wheel Lathe, swing 6ft. by 12ft., vee belt drive. Weight 25 tons.
New **CAPITOL** 9½in. Centre Lathe. Admitting 6ft. between centres.
FACEPLATE Lathe, 9ft. swing.
DEAN, SMITH & GRACE 8in. by 5ft. 6in. Centre Lathe.
7in. **COLCHESTER** Triumph Lathe.
4in. **HERBERT** Screw Cutting Lathe.
New **GURKA** 7in. × 30in. Centre Lathe, full equipment.
REED PRENTICE 10in. × 8ft. Centre Lathe.

GRINDING MACHINES

MYFORD MG 12 Cylindrical Grinder.
CRAVEN Heavy Duty Roll Grinding machine with capacity for rolls 42in. dia. by 12ft. between centres and fitted with automatic cambering. Will take rolls up to 25 tons weight. Fully motorised machine of modern design. Weight 25 tons.
ZENITH Model PH Horizontal Spindle. Hydraulic Surface Grinder, 24in. by 8in. (1953).
LOTH Universal Grinder 10in. by 17in. (new).
CINCINNATI No. 2 Tool and Cutter Grinding Machines.
COVEL No. 2 Tool and Cutter Grinding Machine.
IMPERIA Tool and Cutter Grinder, Model M6AR. (1953).
MATRIX No. 16G Plain Straight Thread Grinder.
SCRIVENER No. 1 Centreless Grinder.
BLAKE No. 1 Tap Chamfering Machine (New).
MATRIX No. 6 Internal Thread Grinders 3in. × 10in.
HEALD Model 81 Internal Grinder.
FELLOWES Model HB Gear Burnishing Machine.
SCRIVENER No. 2 Centreless Grinder.
LUND MPH Cylindrical, 5in. × 18in. Capacity.
RINDIS De-Burring, Trimming and Grinding Machine.
HEALD 72A Internal Grinder.

DRILLING MACHINES

ASQUITH Model OD1 Radial Drilling Machine 4 M.T.
PACERA ½in. Bench and ½in. Pillar Drills (New).
Two **ARCHDALE** 36in. Radial Drilling Machines. No. 4 M.T.
Two 30in. **TAGO** Radial Drills (New) £716.
3 Spindle **ARCHDALE** No. 2 MT Pole Change motors.
MULLER (Almost New) SR23 Radial Drilling and Tapping Machine (two available).

GUILLOTINES

BESCO 42in. × 10 s.w.g. Power Guillotine.
HANDS 4ft. × ¼in. Guillotine.
RHODES 6ft. × ¼in. Guillotine.

MILLING MACHINES

MILWAUKEE Model 5H Vertical Mill, dial type, high speed model with power down feed to head, table 94in. × 18in. (New price U.S. $36,680. This machine is in beautiful condition, offered at a fraction of replacement cost.)
MILWAUKEE 3CE Horizontal Milling Machine, Table 67in. × 15in. (Almost New).
FRITZ WERNER 2211 Universal Mill, 43in. × 12in. table.
DENBIGH Model No. C2 Horizontal Milling Machine.
VICTORIA Junior Omnimil (New).
Two **ARCHDALE** 18in. Automatic Cycle Kneeless Production Millers.
SOMUA Model FH2C Horizontal Miller table 67in. × 14½in. (1953).
CUNLIFFE & CROOM No. 2 Vertical Mill (dial).
FACKS Thread Miller.
ARCHDALE 34in. Plain Horizontal Miller 60in. × 13in. (nearly new).
BEAVER Model VRBP Vertical Miller (New).
CINCINNATI 18in. Manufacturing Mill. 36in. × 12in.
ADCOCK & SHIPLEY No. 3B Plain Mill, 36in. × 10in. table.

PLANING MACHINES

DYE 12 × 3 × 3 Planing Machines, 2 toolboxes on rail (New).

HOLROYD PLANO MILLING MACHINE, capacity 17ft. 6in. × 9ft. 6in., 2 heads on cross rail with 25 h.p. drive, pendent control, weight 50 tons. (Modern machine).

POWER PRESSES

RHODES 1-Ton Open Fronted Bench Press with flange motor and UDAL guards.
LEE & CRABTREE 15-Ton Horning Press.
LEE & CRABTREE 20-Ton Horning Press.
LEE & CRABTREE 35-Ton Double Action Mechanical Press.
H.M.E. Model DCP3 70-ton Double Sided, Double Crank, Single Action Power Press.
Six New **MULLER** Model AMP 22-ton Power Presses. Complete with horn.
Three New **MULLER** Model AMP 35-ton Power Presses.
Two New **MULLER** AMP 45-ton Power Presses.
Two New **MULLER** AMP 60-ton Power Presses. Open Fronted.
Two New **MULLER** AMP 80-ton Geared and Ungeared Power Presses.
BLISS 50-ton Open Front Power Press.

SHAPING MACHINES

BERRY 16in. Shaper.
KLOPP 22in. Shaping Machine.
TORPEX 22in. Shaping Machine.
New **LIMA** 22in. Shaper.

SAWING & FILING MACHINES

WESPA AS4 Bandsawing and Bandfiling Machine, hydraulic feed (similar Do-all V/16).

WATCHMAKERS' MACHINES

MIKRON Automatic Cutter Sharpening Machine.
SAFAG Model 24 Automatic Cutter Relieving Machines.

a few yards from Olympia and Earls Court

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OF HIGH WYCOMBE

NEW MACHINE TOOLS FOR IMMEDIATE DELIVERY FROM OUR HIGH WYCOMBE SHOWROOMS

DRILLING MACHINES

ARBOGA ER 830 40in. arm radial.
RICHMOND SR.2 4ft. Arm Radial.
PROGRESS 3A 1¼in. Pillar Drill.
PACERA A.10 ¾in. Artic. Radial.
IMA A.60S 1in. Pillar Drill.
PACERA MF.5 1in. Pillar Drill.
PROGRESS 2.GS ⅞in. Pillar Drill.
PROGRESS 2.G ⅞in. Bench Drill.
Range of ½in. Bench and Pedestal Drills by, **PROGRESS, PACERA, KERRY, UNION, FOBCO,** etc.

BANDSAWS, HACKSAWS AND SHAPERS

SPEEDAX 16in. Bandsaw.
SPEEDAX 20in. Bandsaw.
WICKSTEED 6in. Hacksaw.
WICKSTEED 8in. Hydramatic Hacksaw.
WICKSTEED 10in. Hacksaw.
VELOX 6in. Hacksaw.
MELBO 6in. Light Duty Hacksaw.
RAPIDOR 6in. Light Duty Hacksaw.
BOXFORD 8in. Shaper.
ALBA 2S 4in. Stroke Shaper.
INVICTA 4M 18in. Stroke Shaper.
INVICTA 6M 24in. Stroke Shaper.

MILLING MACHINES

VICTORIA V.2R Rapidmill Vertical Mill.
VARNAMO FU.2 Universal Mill.
VICTORIA Juniormill Plain Horizontal Mill.
VICTORIA Juniormill Horiz. and Vert. Mill.
CENTEC 2B Horizontal Mill.
MILNES Vertical Mill.
RICHMOND Turret Milling Machine with New Power Down Feed Head.
GIEWONT 2.VR Vertical Mill.

LATHES AND CAPSTANS

SMART & BROWN L.16 Capstan.
SMART & BROWN Model "A" Toolroom Lathe.
SMART & BROWN 1024 Toolroom Lathe.
WILLSON 7½in. Newel Mk. V Lathe.
CARDIFF 7½in. × 40in. Major Lathe.
CROWTHORNE 7½in. S.S. & S.C. Lathe.
MYFORD Super 7B 3½in. Lathe.

GRINDING MACHINES

RIBON RUR.500 Universal Grinder.
EXCEL No. 1 Swing Head Grinder.
CLARKSON Tool and Cutter Grinder.
UNION CARBIDE Tool Grinding and Lapping Machine.

Complete range of Double-Ended Pedestal Tool Grinders and Polishers by **MILFORD, VICEROY, UNION, R.J.H.,** etc., always in stock.

In addition to the above machines we have many popular machines for Early Delivery from our Stock Orders.

A. DOUGLAS CO., LTD.,
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Tel.: High Wycombe 4390 (10 lines)

BROWN & SHARPE No. 2 Universal Milling Machine. Motor drive 5 h.p. 400/440 volts, 3 phase, 50 cycles. Table 46in. by 10in. 16 Spindle speeds 40–1,300 r.p.m. With vertical milling attachment, slotting attachment, rotary milling table, universal dividing head, tailstock, chuck, change gears, and other equipment.

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Kitchen & Wade G.5 4ft. Girder Radial Drilling Machine in new condition. 3 Speeds and 3 Feeds. Further details from:
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SOAG
OFFER:—
USED METAL PLANERS

7ft. × 6ft. × 20ft. **CINCINNATI** Double Column, 2 tool heads on crossrail and one on each upright. Separate motor drive for table and crossrail elevation. Power rapid traverse to table. Table surface 20ft. × 6ft. In transit.

5ft. × 5ft. × 16ft. **ULRO,** 2 tool heads, A.C./D.C. generator set.

5ft. 9in. × 4ft. 11in. × 13ft. 2in. **BILLETER & KLUNZ** Double Column Type NDC/IT. 4,000 with two tool heads on crossrail and one on each upright. Heid-Vulkan electro-magnetic reversing clutch drive and 9-speed gear box.

4ft. × 4ft. × 10ft. **LIBERTY** Openside, 2 tool heads on crossrail and one on upright. D.C. variable speed motor for table and constant A.C. motor for additional movements. Table working surface 4ft. × 10ft., H.P. main motor 30.

3ft. 4in. × 3ft. 4in. × 10ft. **WALDRICH** Hydraulic Double Column type, 2 tool heads on crossrail and one sidehead, separate motor drive for pump unit, rail heads and sidehead, main motor drive 20 H.P. Table size 37½in. × 10ft.

Full details from:—

SOAG MACHINE TOOLS LTD.
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'Phone: RELiance 7201
'Grams: SOTOOLSAG, LONDON, S.E.11

Fielding-Swan S.S. & S.C. Centre Lathe. Taper Turning Attachment New 1958.
Further details from:
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PAISLEY.

Harry Kirk
Eng. Ltd.

can recommend the following modern quality machines from STOCK

AUTOMATICS

WICKMAN 5in. Chucking Automatic.
RYDER Verticalauto, capacity 16in. swing × 8in., 6 spindles.

BORING MACHINES

KEARNS O.B. Horizontal Boring Machine, 2¾in. Spindle. Spindle speeds 15/600 r.p.m. Excellent condition.
JONES 6in. Spindle Horizontal Borer Table 17ft. 6in. × 8ft. Spindle travel 48in. Rapid traverse 84in. per min. Motorised 400/3/50. Weight 70 tons
BULLARD 36in. Vertical Boring Mill.
KITCHEN & WADE Vertical Fine Boring Machine, 14in. stroke. Compound table.

DRILLING MACHINE

ARCHDALE 8-Spindle Hydraulic Vertical Drilling Machine.

GRINDING MACHINES

BROWN & SHARPE No. 5 Surface Grinder, 10in. throat.
BROWN & SHARPE No. 2 Surface Grinder, 18in. × 6in. table.
HEALD No. 172 Gap Bed Internal Grinding Machine, maximum diameter of component 36in.

LATHES

N.D. 8in. × 6ft. S.S. & S.C. Lathe, 30in. between centres.
NOBLE & LUND Heavy Duty Centre Lathe, 22in. centre height × 29ft. between centres. Max. swing over saddle 33in. dia.
HARVEY Heavy Duty Centre Lathe, 42½in. centre height × 52ft. between centres. Max. swing over saddle 5in. dia.

MILLING MACHINES

EDGWICK No. 2 Universal Milling Machine. Working surface of table 38in. × 7½in.
BROWN & SHARPE No. 3A Universal Milling Machine with Vertical Head Attachment. Spindle speeds 30/1,200. Power feed all movements.
COLLET & ENGLEHARDT Keller Type Die Sinking Machine. Model FKf80 capacity 60in. × 30in.

PLANING MACHINES

CLEVELAND Openside Planing Machine, capacity 10ft. × 2ft. 6in.
CINCINNATI Planing Machine, capacity 8ft. × 2ft. 6in.

MISCELLANEOUS MACHINES

Hydraulic Vertical Internal Honing Machine (manufactured by **PETER WOLTERS**). Capacity 0.2in. to 2in.
RAPIDAN Double Helical Gear Generating Machine, 12in. diameter capacity.

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RING BELLS *for machine tools*

LEEDS 63-7398

KEARNS OA Horizontal Borer. Spindle 2½in. dia. No. 5 M.T. Facing head 14in. dia.

NEW PROGRESS No. 1 Bench Drill. Cap. ½in. Speeds to 2,580 r.p.m.

CHURCHILL H.B.A. Internal Grinder Hydraulic.

NEW UNION Model G.15. Double Ended Grinders. Wheels 12in. × 1½in.

CHURCHILL No. 1 Hydraulic Planetary Grinder. Cap with largest spindle 10in. dia. × 18in. long. With 2 grinding spindles.

NORTON Type C 10in. × 36in. Plain Hydraulic Cylindrical Grinder. Admits 24in. × 3in. Wheel. Plunge feed and oscillating wheel. M.D. 400/3/50.

NEW WILLSON 7½in. Newel Mark V Gap-bed S.S. & S.C. Lathe. Admits 3ft. between centres. Speeds to 716 r.p.m. With 2in. hollow spindle.

CENTEC No. 3 Production Miller. Table 62in. × 6in. Automatic hydraulic traverse.

CINCINNATI 34/36 Duplex Hydromatic Miller. Table 64in. × 16in. Hydraulic traverse 36in. with rack variator. Two-way cycle. Hydraulic lift to heads.

ASQUITH Single Spindle Type LDP Profile Miller. Table 17½in. × 15in. Built 1954. As new.

HILMOR Type C.1. Tube Bender. For steel tubes up to 2½in. dia.

BLISS No. 18 Inclinable Power Press. Tonnage 8. Stroke 2in.

BLISS No. 19 Inclinable Power Press. Tonnage 15. Fixed stroke 2in.

CLIFTON & BAIRD 24in. Fully Automatic Cold Saw. Cap. 8in.

MAGEE No. 10 Wiring and Edging Machine. Caps. (max.) 14's gauge sheet and ¼in. wire or 16's gauge sheet and $\frac{3}{16}$in. wire. (min.), 24's gauge sheet and 10's gauge wire.

EDGEWICK No. 1 Simplimil. Table 20in. × 7½in. overall. Speeds to 540 r.p.m. by P.O. gears.

HERBERT Model O Capstan. Speeds 320-6,000 r.p.m. With air operated bar feed and collet chuck. Cap. ½in.

MILWAUKEE 3H Horizontal Miller. Speeds 20-1,000 r.p.m. Table 64in. × 13½in. M.D. 400/3/50.

H. BELL (Machine Tools) LTD., Walter Street, LEEDS 4.

HIGH QUALITY USED MACHINE TOOLS

COVMAC 17in. Swing A.G.H. Gap Bed S.S. & S.C. Lathe. 5ft. 0in. B.C. 400/3/50.
Used **SPRINGFIELD** 10in. Centres Gap Bed Screwcutting Sliding, Surfacing Lathe. 36in. B.C. 400/3/50.
Used **COLCHESTER** 8½in. Centre S.S. & S.C. Gap Bed Lathe. 58in. B.C. 400/3/50.
Used **MITCHELL OF KEIGHLEY** 8½in. Centre A.G.H. Gap Bed S.S. & S.C. Lathe. 4ft. 4in. B.C. 400/3/50.
ARCHDALE 20in. Milling Machine, table size 40in. × 10in., power and rapid traverses to table, reversing spindle, backlash eliminator. 400/3/50.
BARDONS & OLIVER No. 3 Universal Turret Lathe. 400/3/50.
WARNER & SWASEY 1A Turret Lathe. 400/3/50.
RUSSELL Saw Sharpening Machine, max. capacity 42in. diameter. 400/3/50.
ORMEROD 12in. Slotting Machine. 400/3/50.

WE UNDERTAKE REBUILDING OF ALL TYPES OF MACHINE TOOLS

CENTAUR TOOL WORKS,
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Tel. EDGbaston 1118 & 1119. 'Grams Capstan, Birmingham

JONES & LAMSON No. 3 Universal Turret Lathe. Motor drive 400/440 volts 3 phase, 50 cycles. 2in. Hollow spindle Chuck capacity 10in. Swing over bed 21¼in. 12 Spindle speeds 20-1,000 r.p.m. Power feed to turret, saddle and cross slide. Fitted with 12in. four-jaw chuck, square turret, suds pump and fittings.

4/6 Minerva Road, Park Royal, London, N.W.10
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Lang 20in. Surfacing and Boring Lathe, Chuck Model. Excellent Machine. Further details from:—
C. & G. OLDFIELD, LTD.,
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PAISLEY.

6ft. Dia. Tee-slotted Rotary Tables. Weight 5 tons each.—A. McNAMARA & CO., LTD., New Line, Bacup, Lancs. 'Phone: Bacup 946.

Two Gleason 12in. Gear Generators complete with all Equipment including Gleason Gear Checker and Gleason Gear Cutter Sharpener. Can be sold as one lot or separate items. Further details from:
C. & G. OLDFIELD, LTD.
15, Abercorn Street,
PAISLEY.

18in. Centre Lathe, 5ft. Gap Swing, 16ft. 6in. between centres. Vee bed. Cone drive.—F. ATKINSON & SONS (LONDON), LTD., Kings Cross Road, W.C.1.

Manlove Alliott 20in. Oil Separator, spare basket and hand operated jib crane, used only two months, cost £430, offered at £350 ex-works.—Please 'Phone: LIBERTY 6225.

B.S.A. Multi Tool Lathe. Cap 6in. × 20in. Fitted profiling attachment —WILCOX & CO. (B'HAM), LTD., Barr Street, Birmingham 19. NORthern 1234/5.

Town Type A.E.O. Radial Drill, 42in. arm, No. 3 M.T., elevating table, 400/3/50, late model, excellent cond., also Herbert "C" Bench Drill, No. 2 M.T., excellent —C. L. THOMAS, LTD., Stirling Road, Solihull Tel.: 3075-6.

'R-G' HIGH SPEED HYDRAULIC PRESSES

5 Ton bench and pedestal models.
5 Ton pedestal model with broaching and tool setting valve. Foot control.
10 Ton extra high speed model with automatic rotary indexing table and stroke limiting device. Foot control.
10 Ton fully automatic model with automatic rotary indexing table and control desk, ejector mechanism and stroke adjustment.
15 Ton standard model.

EX WORKS STOCK

5, 10 and 15 ton models available for inspection at our London Showrooms.
Write for fully illustrated catalogue.

DOWDING & DOLL LTD
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ROLLS TOOLS LTD.

RICHARDS BORER No. 3 Type PRT. Spindle 3½in. dia. O/d. No. 5 Morse Taper. Speeds 3·8 to 835 r.p.m. 30in. Traverse. Facing Head. 26in. Vertical movement to spindle head. 44in. max. clearance over bed. 31in. max. clearance over top table. Bottom table 36in. × 69in. Top table 42in. × 42in. Vernier slide reading. Rapid power traverse to tables. Motor 12·5 h.p. 400-440/3/50. Overall size 18ft. 6in. long × 7ft. wide × 8ft. 6in. high.

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Phone : Byfleet 43252.

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Classified Advertisements (*PLANT FOR SALE, contd.*)

Classified Advertisements (*PLANT FOR SALE, contd.*)

EDWIN MILLEN & SONS LTD.

70, CLERKENWELL ROAD
LONDON, E.C.1
Tel.: CLE 6064 and 3602

AUTOMATICS

BUTTERWORTH 1¼in. Good equip. 1958.
MANURHIN TR12-16 ⅝in. Auto.
BROWN & SHARPE OG Auto. £650.

DRILLING MACHINES

BRIMSDOWN. 2 Spindle. £65.
PROGRESS 4E, 1¼in. cap. (2). £195.
CORONA 1¼in. 4ft. Radial. £285.
DENBIGH. 1¼in. cap. £125.

GRINDERS

THOMPSON Hydraulic Surface, Type F." 18in. × 6in. £750.
SCRIVENER No. 1 Centreless. £650.
SMART & BROWN Internal. £225.
MYFORD MG9 Cylinder, with internal. £425.
VICTORIA Cyl., 4½in. × 8in. As New. £425.
EXCEL No. 2, 14in. × 6in. Surface. £385.
PALLAS 18in. × 6in. Surface. £275.
NORTON 18in. × 7in. Hyd. Cyl. £295.

CAPSTANS AND LATHES

JOLCHESTER 7in. × 42in. Triumph. £365
HERBERT No. 7 Comb. Turret. £685.
HERBERT No. 9 Comb. Turret. £225.
WARD 3A. B/Chuck, B/Feed. £685.
WARD 3A. Chucking (2). £650.
WARD 2A. B/Chuck, 2,041 r.p.m. £475.
WARD 2A. B/C, B/F Tooling. As New. £750.
SMART & BROWN ⅝in. Model "L," B/F. £225.
ACCURATOOL ⅝in. Capstan. £225.
AKUMA 9in. × 36in. Lathe. G.B. £195.
STUDENT 6in. × 24in. Good equip. £425.
DENHAM 4½in. × 18in. Good equip. £165.
WILLIE RAPID 4½in. × 18in. Good equip. £125.
HERBERT SMALLPIECE 6in. × 24in. £850.
DARLING & SELLARS 10½in. × 12in. £650.
JOHNSTEAD 5ft. 6in. Facing Lathe. £650.
WILSON 7½in. × 36in. Full equip. £285.
WARD No. 7 Capstan Lathe. £550.

MILLERS (Horiz. and Vert.)

ARCHDALE DUPLEX. 45in. × 11in £350.
ADCOCK & SHIPLEY 1VM Vert. £575.
SENIOR M1. 26½in. × 6in. £195.

POWER PRESSES AND SHEET METAL MACHINES

TAYLOR & CHALLEN 40 ton Dial Feed.
BLISS 21. 40 Ton. 3in. stroke. £425.
BESCO 6ft. × ⅛in. Guillotine.
BESCO 40 Ton. Adj. stroke and bed. £425.
BESCO 28 Ton. 2in. stroke. £225.
BESCO 8 Ton. A.P.X. Adj. stroke. £140.
BESCO 4 Ton. Adj. stroke. As New. £125.
MORGAN 6ft. × 14 S.W.G. Folder. As New. £200.
MIDSAW Hyspeed 36in. Fusion Cutter. £485

MISCELLANEOUS

G. H. ALEXANDER Engraver, with rotary table. £175.
ROWLAND 4in. Abrasive Cutter. £150.
THIEL Punch Shaper. As New. £575.
WICKSTEED 10in. × 10in. Powersaw. £195.
RAPIDOR 8in. × 8in. Powersaw. £95.
TAYLOR 12½in. Spinning Lathe. £385.

Other machines in stock

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New for Immediate Delivery: CENTEC Model 2B Precision Milling Machine. Power feed to table.
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CINCINNATI 420-183 DUPLEX HYDROMATIC MILLING MACHINE

Model 'LL', working surface 18in. by 60in. Motorised for standard 3 phase supply, 1960 machine in excellent condition.

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K·E·N·T

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Ward 2C. Late machine. First class.
Ward 3A, good condition, late machine.
Boley & Leinen SR26, 1 1/16in. capacity.
Ward 2A air collet chuck.
Herbert 4BS.

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Colchester Triumph 7½in., as new.
Betts Bridgeford 14in. × 16ft.
Le Blond "Regal" S.S. & S.C. 6½in. × 24in.
Graham & Normanton surfacing and boring. 44in. swing in gap.
Le Blond "Regal" S.S. & S.C. 8in. × 36in.
Lang S.S. & S.C. gap bed, 12½in. × 14ft. Swings 45in. in gap.

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Herbert No. 1 horiz. 16in. × 5in. table.
Herbert No. 10 vert. 25in. × 6½in. table.
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Archdale 14in. horiz. 29in. × 8½in. table.
Rigid 12½in. horiz. built-in telesc. brace.
Archdale 20in. horiz. Very good condition.
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Wickman Moulton 1B thread mill. No. 3 M.T.

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Raskin R5A 60 ton, only one still available.
Raskin R4 50 ton, UDAL guards, only three left.
Sweeney & Blocksidge inc. 30 ton press.

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Rowland 14in. heavy duty, wet and dry grinding.
B.S.A. centreless No. 7. 1/64in.-3in. capacity.
Scrivener No. 1 centreless. 1½in. cap.
Churchill N.B. horiz. surface grinder, 18in. × 6in.
Wright table surface grinder, 12in. cap.
Landis C plain cylindrical. 6in. × 30in.
Brown & Sharpe No. 2 horiz. surface grinder. 18in. × 6in.

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Brown & Sharpe O.G. single spindle, ⅝in. cap.
C.V.A. No. 8 single spindle, ½in. capacity. Very good.

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Herbert single spindle sensitive pillar drill.
Jones & Shipman 2 spindle vertical, flanged motor.
Storey 25 pillar. Good machine.
Progress 2S ¾in. pedestal drill.

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Sigma Type Jig Borer and precision Milling and Drilling machine.
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Heald 48A double headed 'Bore-matic.'
Bradley & Burch 4ft. × 14g. power guillotine.
Dawson rotary washer, 4½in. dia. cap.

All motorised 400/3/50

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WICKMAN 5-Spindle Automatic. ⅞in. capacity. With slotting attachment. Motor drive 400/440 volts, 3 phase, 50.

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KITCHEN & WADE 8ft. low base, with loose box table.

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JUNG AS Internal.
CHURCHILL 8in. × 12in. Internal.
KEIGHLEY Type XL Hydraulic Plain Grinder, 6in. × 18in.
CHURCHILL 10in. × 24in. Universal.
LANDIS 12 × 48 Universal.
BROWN & SHARP No. 3 Universal.

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LIECHTI PR Turret Lathe (Swiss).
GISHOLT Turret Lathes. Type IL.
FOSTER No. 2B Turret Lathe.

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HENDEY 6in. × 30in. Taper Turning.
MONDIALE 7in. × 60in. Gap Bed.

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ADCOCK & SHIPLEY Model OA with "Multiform" Auto feed. Rebuilt.
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CINCINNATI 3-24 Plain Hydromatic.
CINCINNATI 3-24 Duplex Hydromatic.
CINCINNATI 4-36 Duplex Hydromatic.
New TAYLOR Vertical, table 17¾in. × 5½in.
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HERBERT 23V Vert. Table 68in. × 17in. 48in. traverse.
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All machines motorised 400/3/50 unless otherwise stated.

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Electric Motors. Three phase ¼ h.p.-30 h.p. Single phase 2 h.p.-10 h.p. —HICKS MACHINERY, LTD., 26, Addison Place, London, W.11. Tel.: PARk 2333.

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LANG 8½in. × 24in. S.S. & S.C. Lathe, 19-900 r.p.m. Spindle bore 2¼in., 5 h.p.
LANG 10in. × 60in. S.S. & S.C. Lathe. 10-500 r.p.m. Spindle bore 2⅛in. 12½ h.p.
PROGRESSIVE Lathe 10in. centre height. 40in. between centres. Gap bed. 30in. dia. swing. 12 speeds 17-750 r.p.m. Well equipped.
CINCINNATI 8-18 Tool and Die Milling Machine. 185-3,330 r.p.m. Equipped with slotting attachment.
CINCINNATI 1-18 Production Mill.
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EDGWICK Horizontal and Vertical Mill. 11in. × 46in. table, 24-405 r.p.m. Horizontal Vertical Milling attachment, 42-680 r.p.m.
KENDALL & GENT Vertical Mill. Table 19in. × 69in. Speed range 20 × 300 r.p.m.
PRATT & WHITNEY 12B Profile Mill. Twin spindles. 225-2,880 r.p.m.
DOWDING V.8 Gear Hobber. Capacity 6in. dia. Maximum pitch hobbed in one cut 14 d.p. Hob traverse 7¼in., 6-400 teeth. Well equipped.
FRORIEP KE.10 Vertical Boring and Turning Mill. 47in. swing. 39in. diameter, four-jaw chuck. Taper Turning attachment.
BUTLER 14in. Slotter, 6 speeds, 4in. to 14in. stroke. Table diameter 39in., 12½ h.p.
"VOA-55" Jig Borer. Table 32in. × 20in. 16 speeds 35-1,500 r.p.m.
No. 18 BLANCHARD Vertical Surface Grinder. 36in. dia. chuck. Capacity 36in. dia. × 12in. high.
CHURCHILL 30in. × 36in. Heavy Plain Cylindrical Grinding Machine. Capacity 30in. dia. × 36in. between centres.
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HOLROYD 2-Spindle Vertical Profile Milling Machine. Independent motor to each spindle, 400/440 volts, 3 phase, 50 cycles. Table W.S. 18in. by 14in. Spindle speeds to 3,000 r.p.m.

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Le Blond Regal Lathe, 19in. × 48in. A.G.H. 8 speeds to 634. Screwcutting gearbox with extra change gears, 400/3/50 electrics, reversing switchgear. Excellent cond. Chucks, etc. Also 15in. × 36in. in fair cond.—C. L. THOMAS, LTD., Stirling Road, Solihull. Tel.: 3075-6.

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Churchill 12in. × 36in. Universal Grinder complete with all Equipment and Internal Grinding Spindle.
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HERBERT 2SS Chucker.	£325
HERBERT 9 Comb. Turret.	£350
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NERO ⅝in. Collet Capstan.	£175
PITTLER R.B. 36 Capstan.	£250
ACME 4 Spindle Bar Auto.	£450
P. & G. 5D Chuck Auto.	£425
HERBERT 3 Chuck Auto.	£250
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MILWAUKEE 2K Universal.	£1,250
RICHMOND O.1 Universal.	£250
CINCINNATI 1-12 Production.	£550
HERBERT 15S Vert.	£525
ASQUITH Profile Mill.	£450
LE-BLOND Tool & Cutter.	£450
CATCO No. 2 Surface.	£155
J. & S. Tool and Cutter.	£425
WICKMAN Auto Cutter.	£275
HUNT No. 2 Drill.	£225
B. & S. No. 13 Universal	£575
LANDIS 10in. by 30in. Uni.	£750

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AVERY Dynamic Balancing Machine.
CHURCHILL Model HBB Internal Grinder.
LANG 18in. swing Surfacing & Boring Lathe.
PALLAS Model H.O. Miller. Table 30in. × 8in.
CINCINNATI No. 2 Centreless Grinder.
HERBERT No. 1 Hand Milling Machine.
ARCHDALE 18in. Plain Horiz. Miller.
UNIVERSAL Magnetic Chuck with effective area of 60in. × 7in.
MIDSAW 20in. Bandsaw with brazing attach.
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KITCHEN & WADE Column Drill, No. 5 Morse Taper.
WILSON 7½in. × 3ft. 6in. Gap Bed S.S. & S.C. Lathe.
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All machines motorised 400/3/50.

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New 63 × 13½in **LAGUN** Universal Milling machine. Bar feeds and rapids to the table in all directions.
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12in. × 48in. between centres **MONARCH** Toolroom Lathe.
15in. **LE BLOND** S.S. & S.C. Lathe, Heavy Duty. 48in. between centres.
P.24 **SNOW** 10in. × 24in. Hydraulic Surface Grinder, with magnetic chuck and dust extractor.
8½in. **CARDIFF** S.S. & S.C. Lathe, 48in. B.C.
8½in. **CARDIFF** Lathe, fitted with Hydraulic Copying Attachment, 48in. B.C.
59in. × 16in. **CRAVEN** Victoria Milling Machine.
New 60 Ton **DIMCO** Open Fronted Inclinable Adjustable Stroke Power Press.
New 42in. × 10in. **DIMCO** Model CM60 Universal Milling Machine. Power feeds and rapids.
New 10in. × 18in. **GER** Model 450 Hydraulic Universal Grinding Machines.
55in. × 13in. **CRAVEN** Universal Milling Machine.
35in. × 10in. **FRITZ WERNER** Production Milling Machine.
New 51in. × 11½in. **LAGUN** Universal Milling Machine. Power feeds and rapids.
New 40in. × 11in. **DIMCO** Model FV2 Vertical Milling Machine. Power feeds and rapids.
No. 2 **WARNER & SWASEY** Capstan Lathe. Chucking.
43in. × 12in. **FRITZ WERNER** Vertical Miller. Swivelling head.
20in. **ARCHDALE** Plain Miller. Power feeds and rapids. Spindle speeds 60-1,230 r.p.m.
20in. **ARCHDALE** Plain Miller. Power feed and rapids. Spindle speeds 30-615 r.p.m.
No. 3 **KITCHEN & WADE** Honer.
No. 2 **KITCHEN & WADE** Honer.
Model HBY **CHURCHILL** Electric Grinder.
14in. **BUTLER** Slotter. Power revolving table.
No. 3 **RICHARDS** Horizontal Borer Model PRT3.
No. 3 **KEARNS** Horizontal Borer.
No. 2 **KEARNS** Horizontal Borer.
54in. × 15in. **CRAVEN** Universal Milling Machine.
HERBERT S.E. Capstan Lathe.
CRAVEN Worm Milling Machines.

DIMCO (Gt. Britain) LTD.
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SHEpherds Bush 4401/2

SNOW Horizontal Spindle Surface Grinder, hydraulic. Motor drive 400/440 volts, 3 phase, 50 cycles. Table working surface 24in. by 8in.

DISKUS Vertical Spindle Surface Grinder, hydraulic. Motor drive 380 volts, 3 phase, 50 cycles. Table working surface 32in. by 10in. Segmental grinding wheel 14in. diameter.

CHURCHILL Horizontal Spindle Surface Grinder. Motor drive 400 volts, 3 phase, 50 cycles. Table working surface 36in. by 12in.

PRECIMAX Plain Grinder, 6in. × 18in., 400/440 volts, 3 phase, 50 cycles, hydraulic.

R.O.Gray.

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ORMEROD 20in. Stroke Heavy Duty Shaping Machine. 400/3/50.
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CLIFTON & BAIRD 22in./24in. Mechanical Cold Sawing Machine. Self-contained motor drive. 10 h.p. motor. 400-440/3/50.
Used **PRECIMAX** Type UPJ12/72 Hydraulic Universal Cylindrical Grinding Machine, with variable speed workhead and electrics to suit 400/3/50.
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TOWN 28in. Vertical Spindle Drilling Machine. Compound table. 400/3/50.
K. & W. 33in. Sensitive Radial Drilling Machine. Swing-aside table, swing-aside arm. 400/3/50.
JONES & SHIPMAN 20in. Vertical Drilling Machine. No. 4 Morse Taper. Power feed. 400/3/50.
HERBERT No. 0 Horizontal Milling Machine 400/3/50.

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WARD No. 7 Combination Turret Lathe, 12in. 3-jaw chuck. £425.
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COLCHESTER Student, 3 and 4-jaw chucks, faceplate, suds pump. £395.
CARDIFF 17in. Lathe, 4ft between centres, 3 and 4-jaw chucks, 24in. faceplate, etc. £850.
LITTLEJOHN 5in. Lathe, 5in. 3-jaw chuck, 9 collets with drawbar. £145.
FORTIS 6½in. Bench Lathe on stand, Norton gearbox, 3-jaw chuck, faceplate, etc. £75.
HENDY NORTON 8in. Lathe, 3 and 4-jaw chucks, belt drive, faceplate. £75.
C.V.A. Centre Lathe, ⅜in. capacity, with 12 collets. £55.
LANDIS Plain Cylindrical Grinder, 18in. × 7in., power feeds, electric suds. £155.
LANDIS Plain Cylindrical Grinder, 24in. × 7½in. £125.
WOTAN Surface Grinder, 39in. × 8½in. table, power feeds. £295.
CLARKSON Tool and Cutter Grinder. £85.
STEEL 14 kVA Spot Welder. £45.
JOHN HANDS 28 Ton Power Press, 1½in. stroke. £185.

ALL MACHINES MOTORISED 400/3/50.

HELIOT

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WARD No. 2A Capstan Lathe. Chucking Machine, spindle bored 1⅜in. diameter. Power feeds to turret, maximum swing 11½in., maximum distance spindle to turret 17in. Spindle speeds 71-1531, r.p.m. £590.

WARD No. OE Capstan Lathe. ½in. Bar capacity, collet chuck and bar feed, lever feed to cross slide and turret slide, spindle speeds 480-2,850 r.p.m. £225.

WARD No. 3A Capstan Lathe, chucking machine, spindle bored 1⅜in. dia., power feeds to turret, maximum swing 13in., maximum distance spindle to turret 23in., spindle speeds 59-1,155 r.p.m. £625.

HERBERT 15S. Vertical Mill with sliding head, 49in. × 11in. table, 30in. table traverse. 8 Spindle speeds 51-700 r.p.m. £275.

WADKIN LXA. High speed vertical mil with sliding head 17½in. × 40in. table 30in. table traverse, spindle speeds 1,100 and 2,200 r.p.m. £300.

ARCHDALE 2 Spindle pillar drilling machine. Spindles bored No. 3. Morse taper, 4 Speeds to each spindle, 25in. × 15¾in. rise and fall table, complete with coolant unit. £275.

CORONA 12.MX. 12 Spindle Cluster Drilling Machine. Maximum drilling capacity ⅜in. Hand and Foot lever feed to table, 2 speeds to cluster head. 6½in. Circular spindle carrier. £325.

CORONA 12.MX. As above but with 9in. Circular spindle carrier. (Selection of spindles available.) £325.

ARCHDALE 5ft. Radial Drilling Machine Low base, power elevating arm. No. 4 Morse taper spindle with tapping reverse, spindle speeds 40-2,000 r.p.m. Maximum spindle to base 56in. £875.

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RICHARDS No. 2 P.R.T. Horizontal Boring and Facing Machine. 3in. Traversing spindle. 22in. Auto facing head, rapid and power feeds to all traverses, main table 48in. × 30in. Top table 36in. × 36in. spindle speeds 3.5-300. r.p.m. Maximum distance spindle to outer support 5ft. 6in. £2,150.

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Classified Advertisements (*PLANT FOR SALE*), contd.

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HERBERT No. 3S Capstan Lathe. Motor drive 400/440 volts, 3 phase. 50 cycles. Arranged for chucking.

HERBERT No. 2B Capstan Lathe. Motor drive 400/440 volts, 3 phase, 50 cycles. Arranged for chucking.

HERBERT No. 7 Junior Combination Turret Lathe. Motor drive 400/440 volts, 3 phase, 50 cycles. Arranged for chucking.

HERBERT No. 4 Capstan Lathe. Motor drive 400/440 volts, 3 phase, 50 cycles. With dead-length chuck, bar feed, square turret and back toolpost, turret tools.

HERBERT No. 9 Combination Turret Lathe, motor drive 400/440 volts, 3 phase, 50 cycles. Arranged for chucking.

R. O. Gray

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ASQUITH 28in. Vertical Production Mill Table 49in. × 14in. 1,000 r.p.m.
CHURCHILL Model D. Cylindrical Grinder. Cap. 30in. dia. × 56in.
JONES & SHIPMAN Model 745 Slot Hydro-mill. Table 53in. × 10½in.
HANSON WHITNEY Semi Auto Thread Milling Machine. Cap. 8in. dia. × 16in.

THE CAUSEWAY, EGHAM SURREY

EGHAM 4166-7

Willson 8in. S.S. & S.C. Centre Lathe complete with all Equipment, Chucks, etc. Speeds 42–477r.p.m.
Further details from:—
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Automatics, Single Spindle turret type, B.S.A. ⅝in., ½in., 1in., 1⅝in., third slides, equipment, excellent cond. C.V.A. Nos. 8 and 12, equipment, excellent cond. Skoda 20mm., third slide, good cond. Brown & Ward 4-operation ⅝in. and ⅞in., nearly new cond., threading spindles, ⅝in., 3-operation. Good cond. 1¼in., 3 and 4-operations. Good cond.—C. L. THOMAS, LTD., Stirling Road, Solihull. Tel.: 3075-6.

Edwards

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Machine Shop Manager (35/45) required for department containing all types of British and Foreign machine tools and including a fitting section. The machine shop employing about 100 operators is not engaged in production machining but forms part of a precision forging works in the West Riding. Applicants will be expected to have considerable experience in management as well as possessing high technical ability. Staff pension scheme in operation. In reply state full particulars of education, previous experience and salary range expected, marking envelope "For the attention of the Works Manager."—BOX D 451, MACHINERY, Clifton House, Euston Road, N.W.1.

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Stating age, experience and salary level required.

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(Continued on page 146)

INDEX TO ADVERTISERS *(Continued from page 145)*

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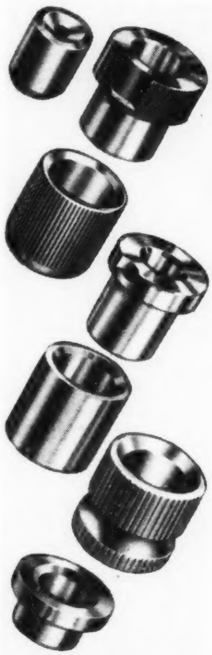

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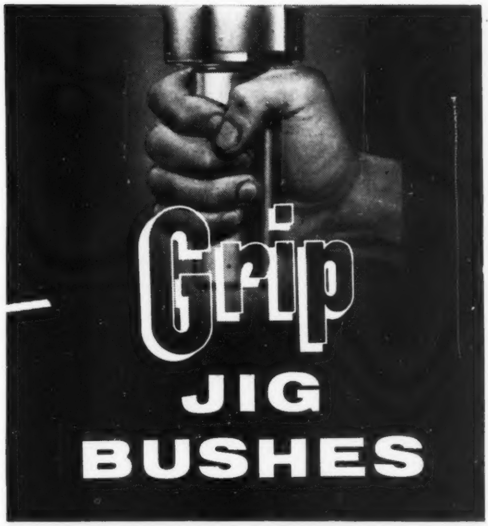

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